# T800-02 CTCSS Encoder/Decoder

21st April 1999

## Applicability

This Technical Note (TN) applies to T800 Series I base station equipment and T700 series duplex two-way radios.

## Introduction

The T800-02 CTCSS unit is designed to operate with the T800 Series I range of receivers and transmitters. It will encode and decode CTCSS tone frequencies within the range 67 to 250.3Hz and is compatible with any other CTCSS unit which conforms to EIA RS220. The T800-02 has silent squelch tail circuitry fitted to improve communication quality.

When fitted to a T800 Series I radio, the T800-02 is internally mounted above the audio processor section onto screw lugs provided on the chassis. Provision has been made for two units to be fitted for dual tone CTCSS if required.

The T800-02 CTCSS unit can also be fitted to a T700 duplex radio. The T700 duplex radio may be configured in a variety of fashions, including repeater or line control base. The T800-02 is also compatible with the T700 600 ohm interface PCB.

This TN replaces TI-346D. Any part that has changed from TI-346D is indicated by a vertical line in the outer margin of the page. If you have any questions about this TN or the procedures it describes, please contact your nearest Tait Dealer or Customer Service Organisation. If necessary, you can get additional technical help from Customer Support, Radio Systems Division, Tait Electronics Ltd, Christchurch, New Zealand.

## Parts Required

The T800-02 CTCSS kit should contain the following items for fitting the T800-02 PCB to a T800 Series I receiver or transmitter:

1 x T800-02 CTCSS PCB
1 x wiring loom complete with socket
2 x M3x8 pan Torx screws

You will also need the following components if fitting the T800-02 PCB to a T700 radio:

1 x 10k chip resistor
1 x 12k resistor
2 x 1N4531 diodes
180mm x double sided foam tape

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## Fitting The T800-02 To A T800 Series I

1. Mount the T800-02 PCB in the T800 Series I receiver or transmitter as shown in Figure 1.

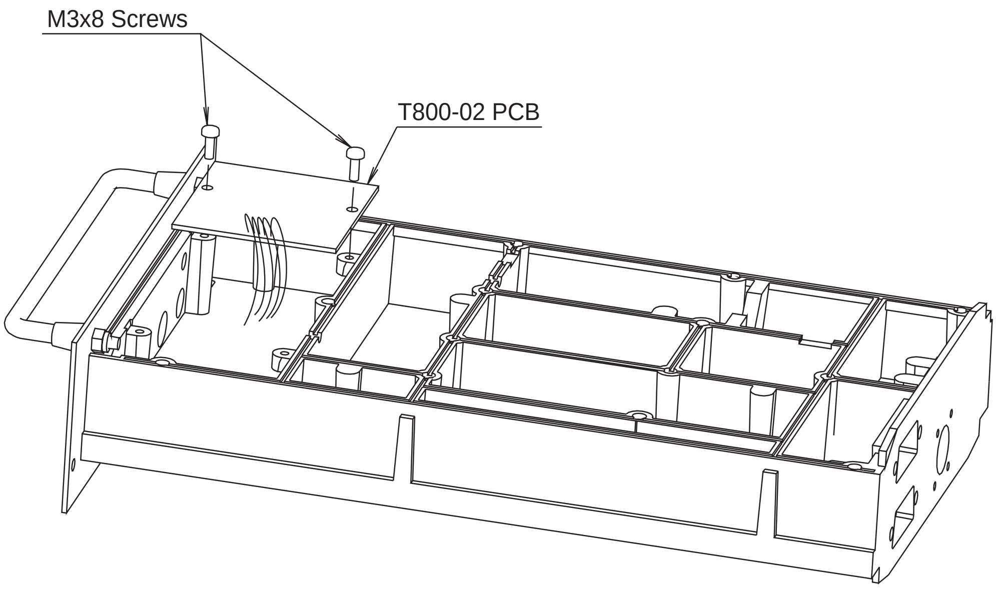


*Figure 1 T800-02 To T800 Series I Mounting Details*

2. Connect the T800-02 to the audio and power supply points in the audio processor as shown in Figure 2 (receivers) or Figure 3 and Figure 4 (transmitters).

***Note 1:*** For older model receivers without "MUTE I/PA", replace R160 with a zero ohm resistor and connect S3 to "MUTE I/P" (refer to Technical News No. 51).

***Note 2:*** For T825 receivers, connect S3 to "MUTE I/P2".

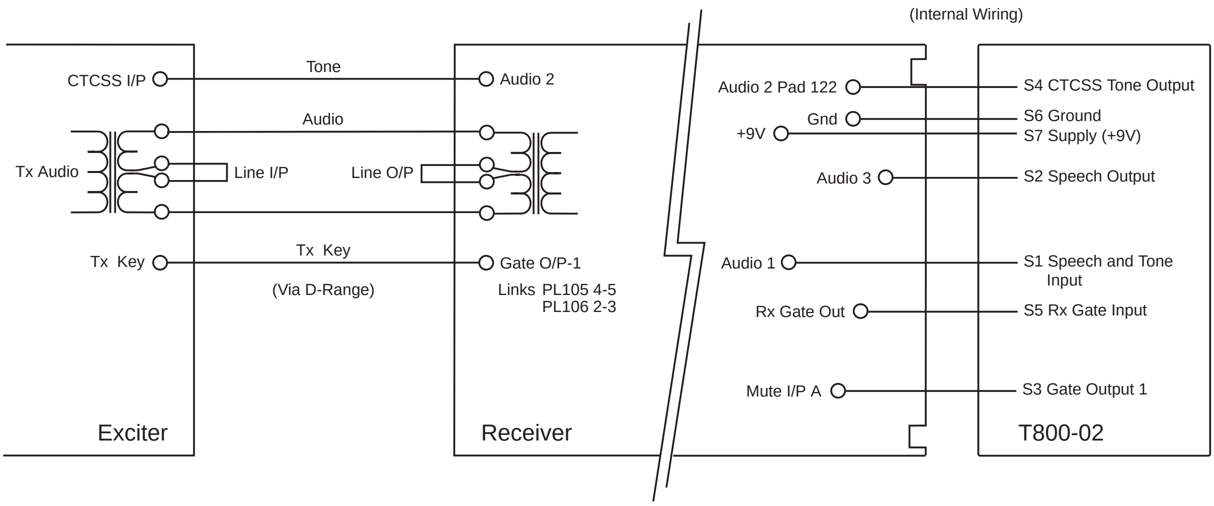


*Figure 2 Receiver CTCSS Wiring Details*

***Note 3:*** If fitting a T800-02 PCB to a T800 Series I module already fitted with a T800-07 multichannel PCB, remove C19 from the T800 PCB.

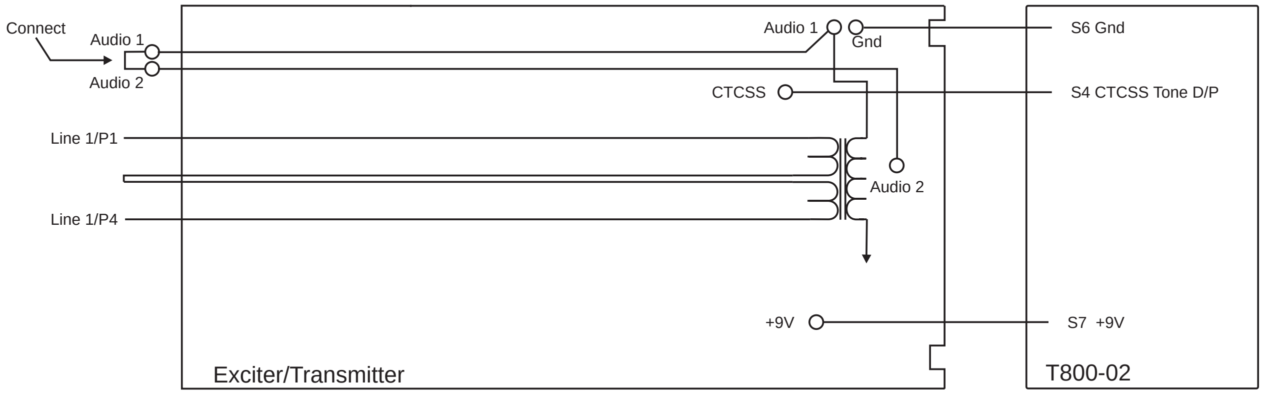


***Figure 3 Transmitter CTCSS Wiring Details***

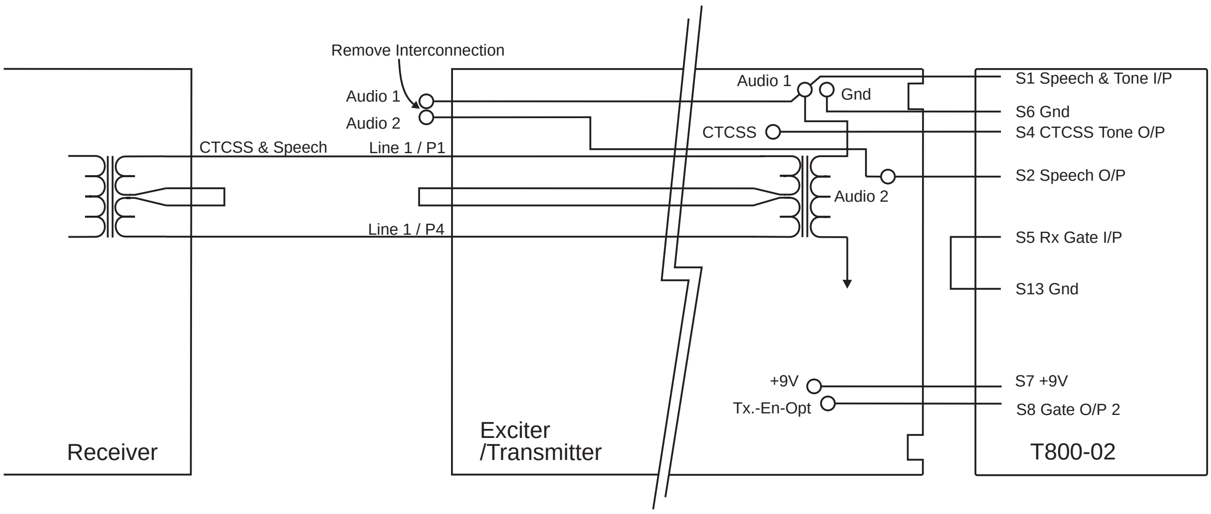


***Figure 4 Talk Through Repeater Wiring***

## Fitting The T800-02 To A T700

### T800-02 PCB Modifications

1. Replace R78 with the 10k chip resistor provided and solder the 12k resistor between S8 and ground, as shown in Figure 5.

2. Remove the wire from S5 and solder the two 1N4531 diodes between S5 and the end of the wire, as shown in Figure 6 and Figure 8.

   Slide a length of silicone rubber sleeving over the two diodes.

***Note:*** Orientate the diodes so that the diode cathodes face away from the T800-02 PCB.

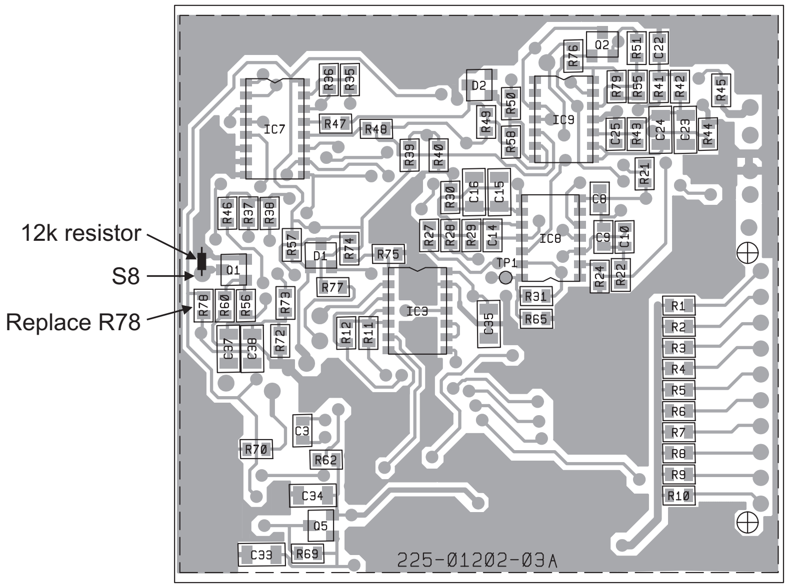


***Figure 5 T800-02 PCB Layout - Bottom Side***

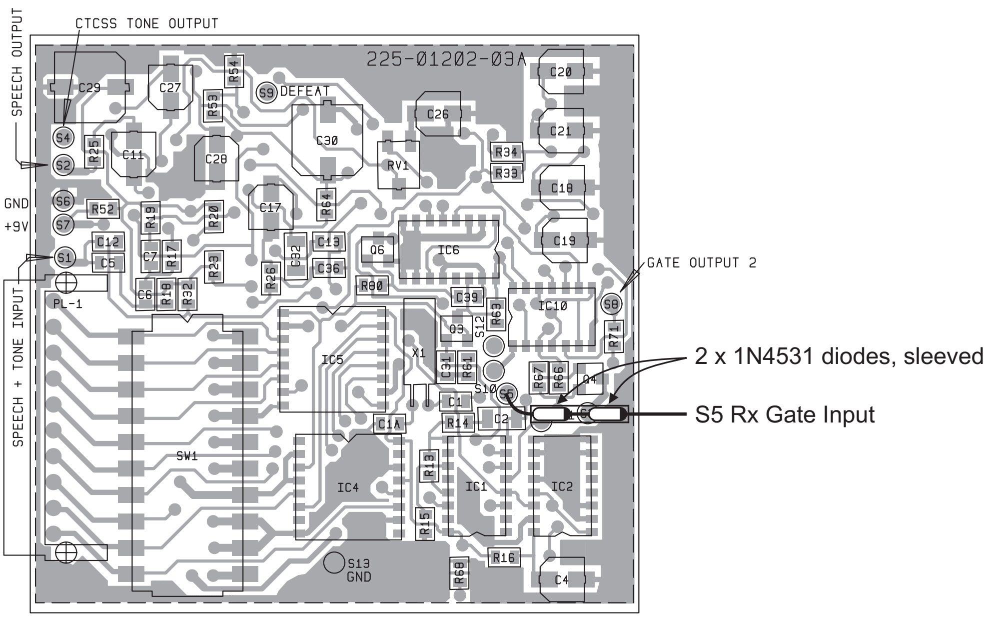


***Figure 6 T800-02 PCB Layout - Top Side***

## T700 Control PCB Modifications

1. Cut the track from pin 5 of IC209 and remove R99, as shown in Figure 7. Solder the T800-02 wire from S8 to the test pad indicated in Figure 7.

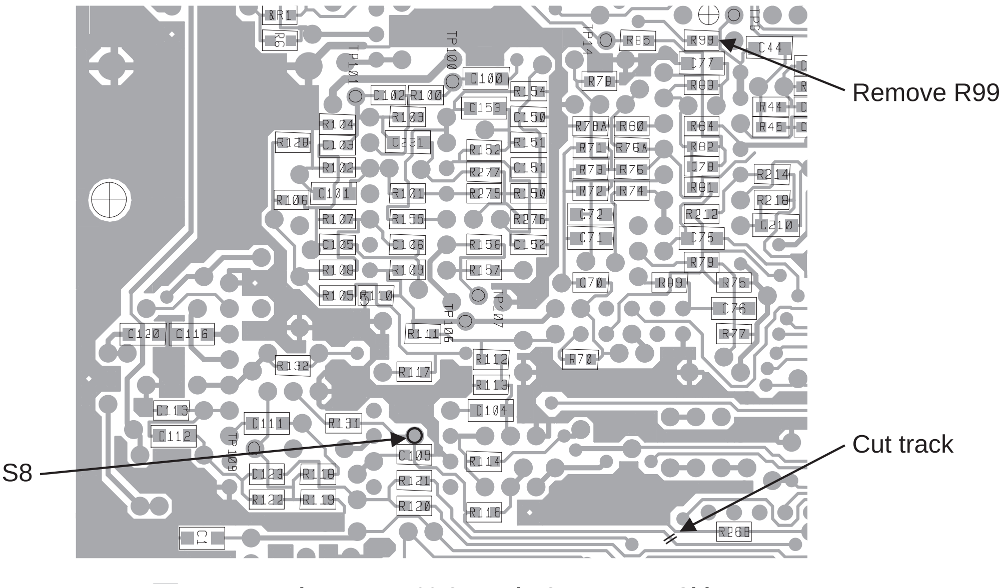


*Figure 7 T700 Control PCB - Bottom Side*

2. Attach the wires from the T800-02 PCB to the top side of the T700 control PCB as follows (refer to Figure 8):

| T800-02 PCB | T700 Control PCB |
|---|---|
| S1 | P5 Pin 8 (Rx--Det--Audio) |
| S4 | P 5 Pin 16 (Tx--CTCSS) |
| S5 | IC209 Pin 5 (Aud--Mute) |
| S6 | P5 Pin 19 (Gnd) |
| S7 | P5 Pin 14 (+9V--SW) |

Cut the unused wires (S2, red and S3, orange).

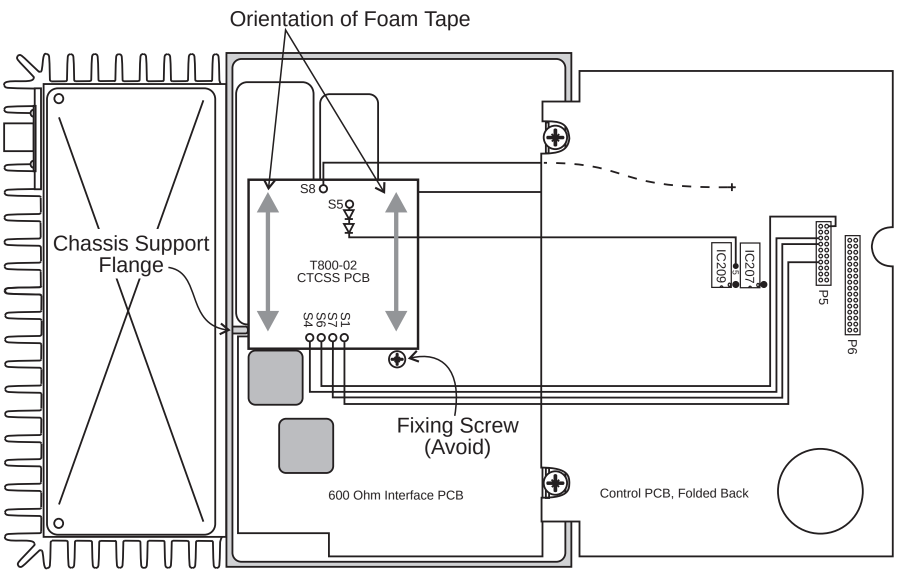


*Figure 8 T800-02 To T700 Mounting Details*

3. Trim the component legs on the back of the T800-02 PCB, so that once the PCB is in place the legs will not short circuit against the T700 receiver shield or chassis.

4. Cut the double sided foam tape into three pieces of equal size. If the T700 is fitted with a 600 Ohm interface PCB, discard one piece of tape and position the remaining two pieces on the bottom of the T800-02 PCB. The two strips of tape should be flush with the PCB edges, and run in the direction shown by the arrows in Figure 8.

   If the T700 is ***not*** fitted with a 600 Ohm interface PCB, stick two of the lengths of tape together so that they can be used as a double thickness. Position the tape on the bottom of the T800-02 PCB as shown in Figure 8, with the double thickness on the side that will be closest to the unfolded control PCB.

5. Position the T800-02 carefully so that none of its components come into contact with parts on the closed control PCB. Avoid contact with the 32V regulator coil by placing the CTCSS PCB hard up against the chassis support flange indicated in Figure 8, and as close as possible to the centre line of the radio.

***Note:*** Ensure that the T800-02 does not come into contact with the 600 Ohm interface PCB fixing screw indicated in Figure 8.

The M3x8 Taptite screws provided in the kit are for fitting a T800-02 PCB to a T800 Series I radio, and can be discarded.

When fitting the T800-02 PCB to a T700 that is equipped with the Talk Through option, the following modifications are necessary to restrict Talk Through to valid CTCSS only:

- Cut the track between R1 (10kΩ) and the connector (PL7) on the Talk Through PCB.
- Connect a wire between pad S12 on the T800-02 and the connector-side leg of R1.

## Programming

Refer to Table 1 and Figure 9.

The DIP switch codes for standard EIA tones are set out in Table 1 on the following page. Programme the DIP switch (SW1) on the T800-02 PCB as shown in Figure 9.

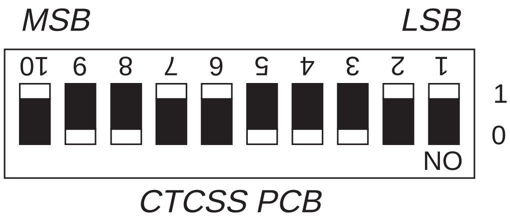


***Figure 9 DIP Switch Programming***

### Non-standard Tones

1. Calculate "n": $n = \dfrac{40960}{\text{tone frequency required}}$

2. Round off to the nearest whole number.

3. Convert to binary code and programme the DIP switch (LSB to "1" switch and MSB to "10" switch) as shown in Figure 9.

   Example: tone frequency = 67.0Hz $\dfrac{40960}{67}$ = 611.343

   therefore n = 611

   convert n to binary code:

| n | n ÷ 2 = | Remainder (Switch Position) | Switch Number | Significance |
|---|---|---|---|---|
| 611 | 305 | 1 | 1 | LSB |
| 305 | 152 | 1 | 2 | |
| 152 | 76 | 0 | 3 | |
| 76 | 38 | 0 | 4 | |
| 38 | 19 | 0 | 5 | |
| 19 | 9 | 1 | 6 | |
| 9 | 4 | 1 | 7 | |
| 4 | 2 | 0 | 8 | |
| 2 | 1 | 0 | 9 | |
| 1 | 0 | 1 | 10 | MSB |

| EIA Frequency (RS220) | Actual Frequency | Error % | n | Switch Code[a] MSB … LSB |
|---|---|---|---|---|
| | | | | 10 9 8 7 6 5 4 3 2 1 |
| 67.0 | 67.04 | +0.06 | 611 | 1 0 0 1 1 0 0 0 1 1 |
| 71.9 | 71.86 | -0.06 | 570 | 1 0 0 0 1 1 1 0 1 0 |
| 77.0 | 76.99 | -0.01 | 532 | 1 0 0 0 0 1 0 1 0 0 |
| 82.5 | 82.58 | +0.10 | 496 | 0 1 1 1 1 1 0 0 0 0 |
| 88.5 | 88.47 | -0.04 | 463 | 0 1 1 1 0 0 1 1 1 1 |
| 94.8 | 94.81 | +0.02 | 432 | 0 1 1 0 1 1 0 0 0 0 |
| 100.0 | 99.90 | -0.10 | 410 | 0 1 1 0 0 1 1 0 1 0 |
| 103.5 | 103.43 | -0.06 | 396 | 0 1 1 0 0 0 1 1 0 0 |
| 107.2 | 107.23 | +0.02 | 382 | 0 1 0 1 1 1 1 1 1 0 |
| 110.9 | 111.00 | +0.10 | 369 | 0 1 0 1 1 1 0 0 0 1 |
| 114.8 | 114.73 | -0.06 | 357 | 0 1 0 1 1 0 0 1 0 1 |
| 118.8 | 118.72 | -0.06 | 345 | 0 1 0 1 0 1 1 0 0 1 |
| 123.0 | 123.00 | 0.0 | 333 | 0 1 0 1 0 0 1 1 0 1 |
| 127.3 | 127.20 | -0.08 | 322 | 0 1 0 1 0 0 0 0 1 0 |
| 131.8 | 131.70 | -0.07 | 311 | 0 1 0 0 1 1 0 1 1 1 |
| 136.5 | 136.53 | +0.02 | 300 | 0 1 0 0 1 0 1 1 0 0 |
| 141.3 | 141.24 | -0.04 | 290 | 0 1 0 0 1 0 0 0 1 0 |
| 146.2 | 146.29 | +0.06 | 280 | 0 1 0 0 0 1 1 0 0 0 |
| 151.4 | 151.14 | -0.17 | 271 | 0 1 0 0 0 0 1 1 1 1 |
| 156.7 | 156.93 | +0.15 | 261 | 0 1 0 0 0 0 0 1 0 1 |
| 162.2 | 161.90 | -0.19 | 253 | 0 0 1 1 1 1 1 1 0 1 |
| 167.9 | 167.87 | -0.02 | 244 | 0 0 1 1 1 1 0 1 0 0 |
| 173.8 | 173.56 | -0.14 | 236 | 0 0 1 1 1 0 1 1 0 0 |
| 179.9 | 179.65 | -0.14 | 228 | 0 0 1 1 1 0 0 1 0 0 |
| 186.2 | 186.18 | 0.0 | 220 | 0 0 1 1 0 1 1 1 0 0 |
| 192.8 | 193.21 | +0.20 | 212 | 0 0 1 1 0 1 0 1 0 0 |
| 203.5 | 203.78 | +0.14 | 201 | 0 0 1 1 0 0 1 0 0 1 |
| 210.7 | 211.13 | +0.20 | 194 | 0 0 1 1 0 0 0 0 1 0 |
| 218.1 | 217.87 | -0.10 | 188 | 0 0 1 0 1 1 1 1 0 0 |
| 225.7 | 226.30 | +0.27 | 181 | 0 0 1 0 1 1 0 1 0 1 |
| 233.6 | 234.06 | +0.20 | 175 | 0 0 1 0 1 0 1 1 1 1 |
| 241.8 | 242.37 | +0.23 | 169 | 0 0 1 0 1 0 1 0 0 1 |
| 250.3 | 249.76 | -0.22 | 164 | 0 0 1 0 1 0 0 1 0 0 |

a. "0" = on, "1" = off.

***Table 1***

**Remote Programming Of Encode/Decode Tones**

If remote tone programming is required, a 10-wire loom and socket is provided in the kit for wiring to an additional connector at the rear of the T800 Series I or T700 radio. Fit the socket to PL-1 on the T800-02 PCB and solder the wires to the connector. When using the remote cable, programme the DIP switch (SW1) on the T800-02 to all "1"s (off).

The T800 Series I can also be remotely programmed using a T800-07 multi-channel memory PCB in place of the standard T800-10 PCB. As well as allowing remote programming, the T800-07 PCB automatically defeats the CTCSS on any channels that are not programmed with a CTCSS tone (provided the programming software used is PGM800 v2.01 or later, and the CTCSS PCB is IPN 225-01202-02 or later.)

For instructions on fitting the T800-07 PCB, see TI-356.

### 2 Channel CTCSS Operation On A Single Channel Using 2 T800-02 Units

Refer to Figure 10. This configuration is available only when the T800-02 is fitted to a T800 Series I radio.

The transmitter is keyed only if the receiver gate is open and one correct tone is present; if two simultaneous tones are received, the gate out 2 of T800-02 No. 2 is inhibited.

The encoded tone output to the transmitter is the same frequency as the received and decoded tone.

A decode on one unit inhibits the decoding of the other and switches off the encode tone.

Each tone level can be set independently by receiving the correct input tone for each decoder or by utilising the defeat line of each decoder.

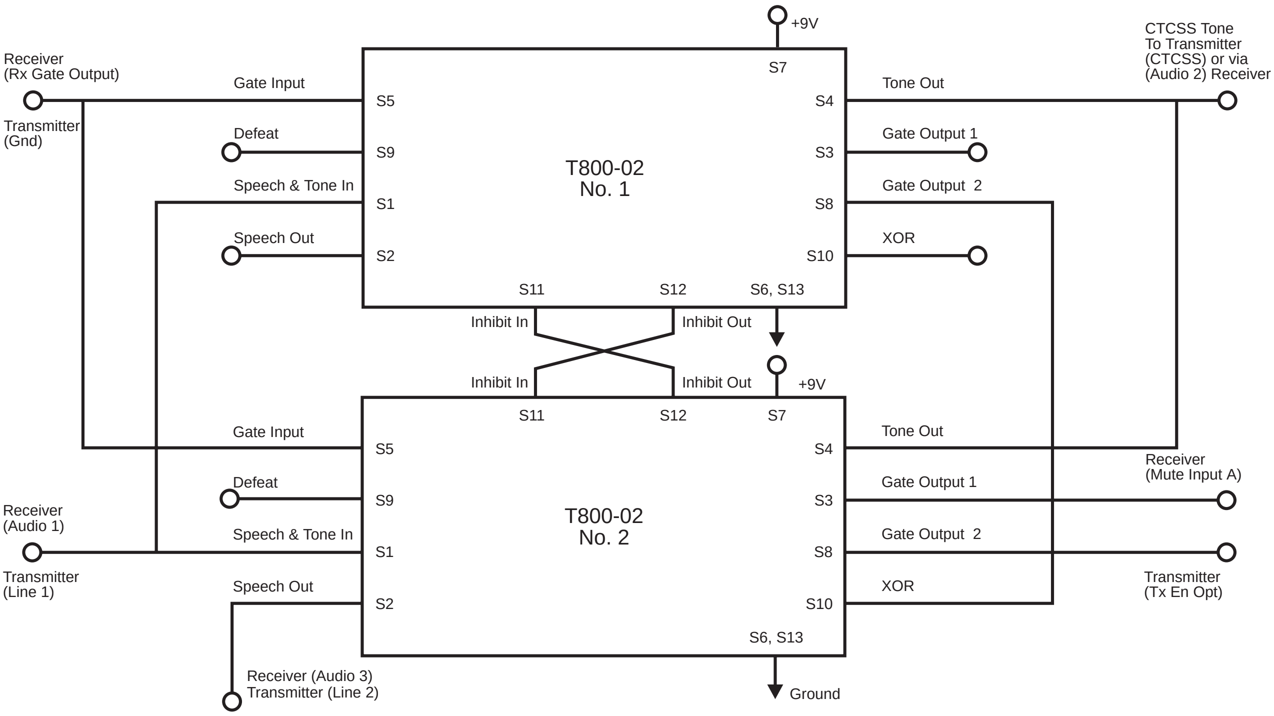


*Figure 10 Dual T800-02 Connection Details*

Both T800-02 units can be mounted side by side above the audio processor on the lugs provided (refer to Figure 1). The wiring loom for remote programming the encode/decode tones can also be installed for both units by mounting one T800-02 above the line transformer right side up, and the other upside down.

The Tx tail time should not be used unless measures are taken to delay the removal of the inhibits at S11 during the tail time. Refer to Customer Support, Radio Systems Division, Tait Electronics, Christchurch, New Zealand for assistance with these modifications. If these measures are not taken, CTCSS tones will be transmitted from both PCBs during the tail time.

# Adjustments

### T700 Series

Adjust RV1 on the T800-02 PCB to provide approximately 10% of the maximum system deviation (e.g. if maximum system deviation is ±5kHz, adjust RV1 for ±500Hz deviation).

### T800 Series I

Refer to Figure 2.

***Note:*** For narrow band sets use half the stated deviation levels.

1. Set the receiver RF mute pot (RV100) to the required threshold (e.g. 20dB sinad).

2. Set the receiver line level pot (RV102) for -10dBm using a steady received RF signal at approximately -70dBm.

3. Programme the required CTCSS tone.

4. Adjust RV1 on the T800-02 PCB to provide ±600Hz (nominal) tone deviation of transmitter modulation.

5. **Transmitter Deviation**

   This must be reset so that the maximum deviation for both audio and CTCSS does not exceed ±4.7kHz.

   Adjust the transmitter line sensitivity pot (RV100) fully clockwise.

   Adjust the transmitter deviation pot (RV106) to set the maximum total deviation of the CTCSS tone and 1kHz AF to ±4.7kHz.

   Sweep the audio frequency from 100Hz to 4kHz and ensure that the maximum deviation does not exceed 4.7kHz.

   Readjust RV106 if necessary.

   Readjust the line sensitivity for ±3kHz deviation.

6. **Transmitter Tail Timer**

   The transmitter tail timer must be set up if reverse phase burst is required.

   Adjust RV202 to obtain the required tail setting (approximately 80ms) as follows:

   - Observe the “Tx Reg” line of the transmitter with an oscilloscope and trigger on the rising edge of the “Tx Key” (scope: 2V/div, 20ms/div, normal trigger).
   - Adjust RV202 fully clockwise and then adjust anticlockwise while keying the transmitter on/off until the required tail is obtained.
   - Alternatively, change R245 from 1k5 to 22k and adjust RV202 fully clockwise.

# Testing (T800 Series I Only)

## Test Equipment Required

frequency counter
RF signal generator
audio level meter
modulation monitor
sinadder
50 ohm dummy load to suit transmitter
2 audio generators & combining pad (refer to Figure 12)

## Receiver Performance Tests

Refer to Figure 2 and Figure 11.

***Note:*** For narrow band sets use half the stated deviation levels.

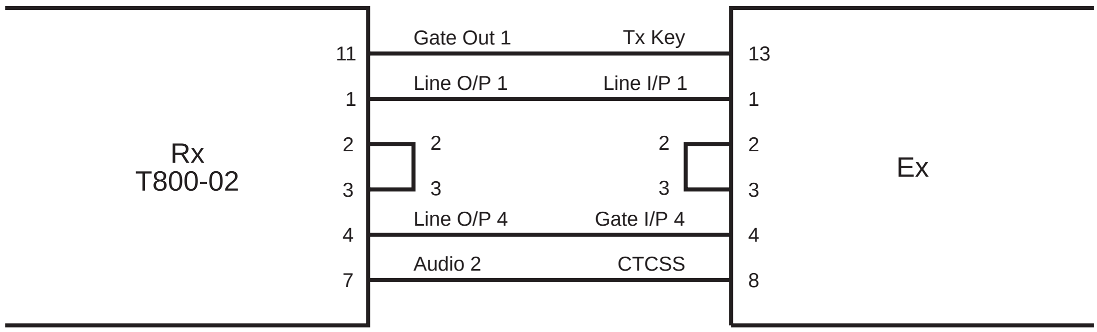


***Figure 11 D-Range Connections (T800-02 Mounted In Receiver)***

1. Set up the T800 Series I receiver and transmitter as detailed in the appropriate Service Manual and then fit the T800-02.

2. Set up the test equipment as shown in Figure 12.

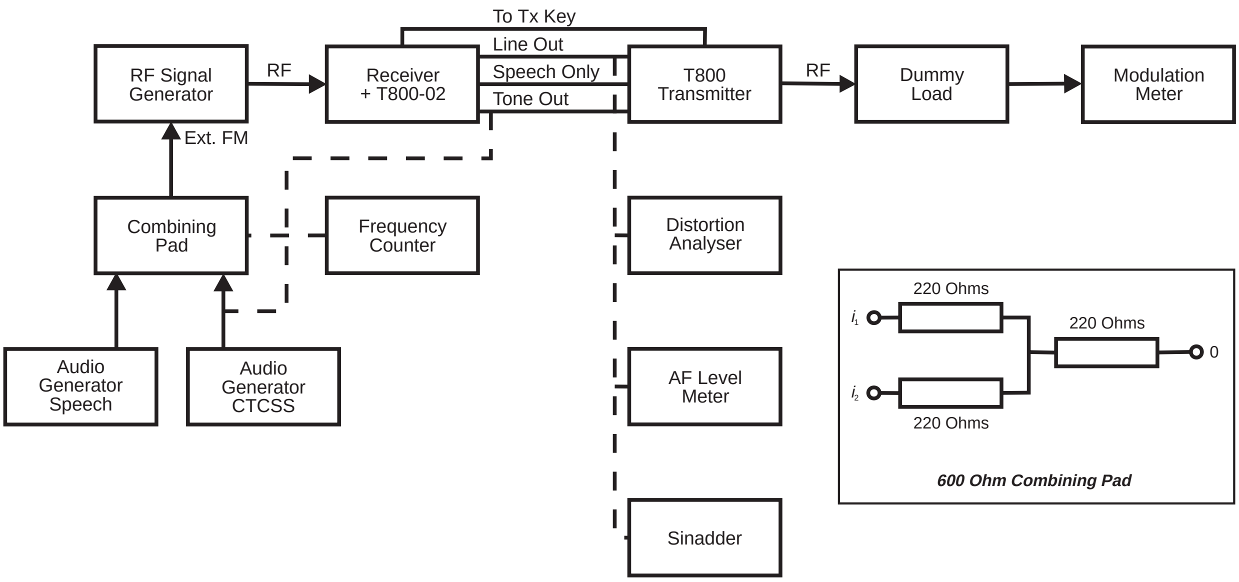


***Figure 12 Receiver Test Set-Up***

3. **To Check Decoder Operation**

   Set the RF signal generator output to -70dBm.

   Modulate the generator with the audio oscillator at a level to give ±3kHz deviation at 1kHz (CTCSS generator set to zero output).

   Monitor the CTCSS generator frequency and increase the level until the total deviation is ±3.5kHz (±500Hz CTCSS deviation).

   Adjust the CTCSS generator to a programmed tone frequency.

   Check that the receiver gate is open, the gate LED is on and Tx key is low.

4. **To Check The Opening Sinad**

   Adjust the receiver gate sensitivity (RV100) fully clockwise.

   Reduce the RF signal level to -110dBm.

   Observe the sinad meter and reduce the RF level until the receiver mute closes.

   Slowly increase the signal level until the receiver mute just opens and stays open.

   Check that the sinad is less than 6dB.

5. **To Check The CTCSS Tone Output Level, Frequency & Distortion**

   Set the RF signal generator as in 3.

   Measure the regenerated tone frequency level and distortion at the tone output.

   Adjust RV1 (T800-02) and check that the tone level can be adjusted from 0 to at least 1V rms.

   Check that the tone frequency is correct and the distortion is less than 5%.

6. **To Check The High Pass Filter**

   Set the signal generator output to -70dBm and modulate with 1kHz and CTCSS (i.e. ±3kHz plus ±500Hz).

   Note the line level (-10dBm).

   Reduce the 1kHz generator to zero output and measure the difference in level between the 1kHz and the CTCSS tone.

   Check that this is at least 26dB below the 1kHz level (26dB de-emphasised, 33dB flat response).

### Transmitter Performance Tests

Refer to Figure 3 and Figure 13.

***Note:*** For narrow band sets use half the stated deviation levels.

1. Set up the T800 Series I transmitter and receiver as detailed in the appropriate Service Manual and then fit the T800-02.

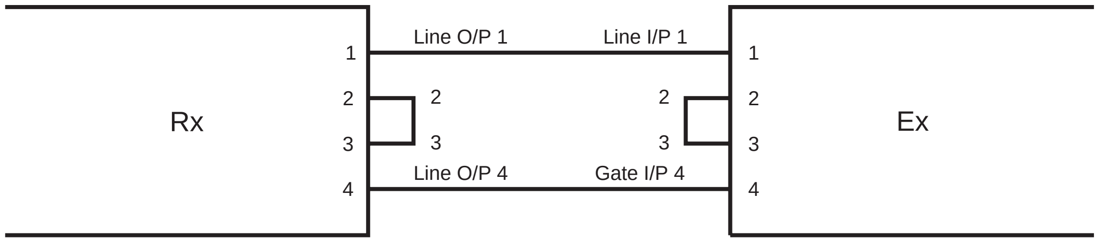


*Figure 13 D-Range Connections (T800-02 Mounted In Exciter)*

2. Set up the test equipment as shown in Figure 14.

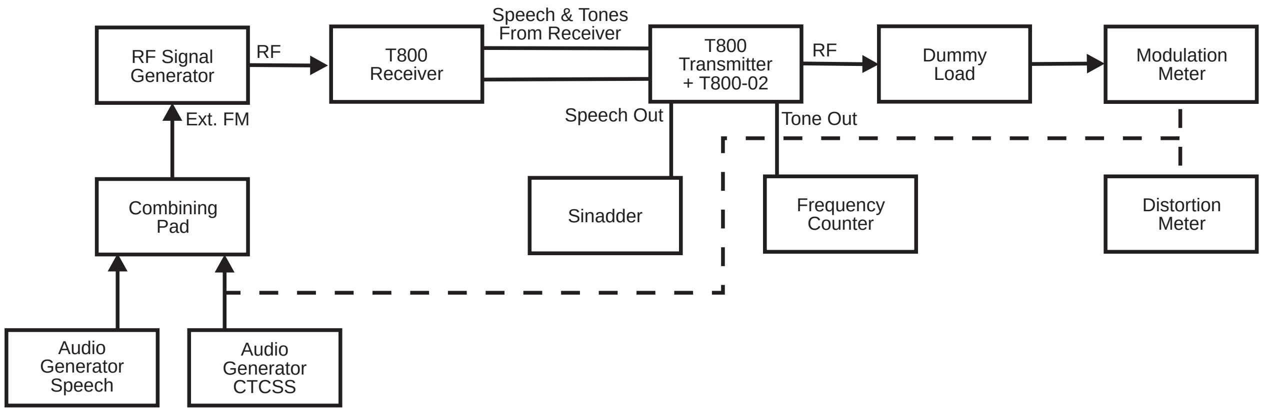


*Figure 14 Transmitter Test Set-Up*

3. **To Check Decoder Operation**

   Set the RF signal generator output to -70dBm.

   Modulate the generator with the audio oscillator at a level to give ±3kHz deviation at 1kHz (CTCSS generator set to zero output).

   Monitor the CTCSS generator frequency and increase the level until the total deviation is ±3.5kHz (±500Hz CTCSS deviation).

   Adjust the CTCSS generator to a programmed tone frequency.

   Check that the transmitter is now keyed and the key LED is on.

4. **To Check The Opening Sinad**

   Adjust the receiver gate sensitivity (RV100) fully clockwise.

   Reduce the RF signal level to -110dBm.

   Observe the sinad meter and reduce the RF level until the transmitter key is removed.

   Slowly increase the signal level until the transmitter is keyed and stays keyed.

   Check that the sinad is less than 6dB.

5. **To Check The CTCSS Tone Output Level & Distortion**

   Set the RF signal generator as in 3.

Measure the regenerated tone frequency and level at the tone output.

Adjust RV1 (T800-02) and check that the tone level can be adjusted from 0 to at least 1V rms.

Check that the tone frequency is correct and the distortion is less than 5%.

Adjust RV1 to give ±500Hz deviation at the transmitter output (key the transmitter via carrier only; push button SW101).

6. **To Check The High Pass Filter**

Set the signal generator output to -70dBm and modulate with 1kHz and CTCSS (i.e. ±3kHz plus ±500Hz).

Note the level at the speech output.

Reduce the 1kHz generator to zero output and measure the difference in level between the 1kHz and the CTCSS tone.

Check that this is at least 26dB below the 1kHz level (26dB de-emphasised, 33dB flat response).

## Specifications

### General

| | |
|---|---|
| Frequency Range | .. 67 to 250.3Hz |
| Number Of Tones | .. single frequency |
| Supply Current | .. 15mA |
| Supply Voltage | .. 9V (from T800 Series I receiver or transmitter) |
| Operating Temperature Range | .. -30°C to +60°C |
| Dimensions | .. 52 x 58mm |
| Height | .. 10mm |

### Decoder

| | |
|---|---|
| Audio Input Level | .. 20mV rms to 2V rms |
| Tone Squelch Opening | .. better than 6dB sinad (5dB typical) |
| Tone Detect Bandwidth: | |
| Minimum | .. ±2Hz |
| Maximum | .. ±4Hz |
| Response Time Encoder/Decoder | .. 150ms (120ms typical)<br>(from tone applied to tone out [90% level]) |

| | | |
|---|---|---|
| Speech Filter Response | .. | 400Hz to 3.5kHz +1.0, -1.5dB rel. to 1kHz |

Speech Filter Tone Band Attenuation:

| | | |
|---|---|---|
| 200Hz to 250.3Hz | .. | better than 19dB |
| 150Hz to 200Hz | .. | better than 30dB |
| 67Hz to 150Hz | .. | better than 45dB |

**Encoder**

Transmit Tones:

| | | |
|---|---|---|
| Level | .. | 1.0V rms nominal |
| Flatness | .. | 1dB ripple |

| | | |
|---|---|---|
| Tone Modulation | .. | 0.5 to ±1.0kHz for ±5kHz full rated deviation (recommended level is ±0.6kHz) |

Tone Distortion:

| | | |
|---|---|---|
| 67Hz to 100Hz | .. | <5% |
| 100Hz to 250.3Hz | .. | <2.5% |

| | | |
|---|---|---|
| Frequency Error From EIA Tones | .. | 0.27% maximum (refer to Table 1) |

## Circuit Operation

### Clock Signal Generator

A 32.768kHz crystal oscillator provides a reference to the phase input comparator input A of the phase locked loop (IC1). The output of the VCO is returned to the phase comparator input B via a ten times divider. In this way the VCO oscillates at ten times the crystal frequency (327.68kHz).

### Programmable Dividers

IC4 and IC5 form a programmable divide-by-”N”. This is capable of 12-bit binary programming, although only 10 bits are used. Programming is achieved by setting the 10-bit DIP switch (SW1), or remotely with a T800-07 multichannel EPROM PCB.

### Level Translator

A level translator is used on the output of the programmable divider to convert +5V logic to the +9V logic required by IC6 & IC7.

### No-Tone Defeat Operation

This allows remote control of the T800 Series I base station equipment when a CTCSS tone is not required. Defeat operation can be activated by providing a high frequency output of about 164kHz from the programmable divider, IC4 and IC5. This is achieved by selecting divide-by-two on the bit switch, SW1, or via the remote lines to the T800-07

EPROM. A divide-by-two output from the T800-07 occurs when the EPROM is programmed by PGM800 ***without the selection of a CTCSS tone*** (PGM800 V2.01, after April 1991 only).

R80, C39 and Q6 act as an integrator to detect the high frequency output from IC4 and IC5 and pull the defeat line, S9, low. The resultant 20kHz tone is prevented from appearing at the CTCSS tone output, S4, by the CTCSS filter, IC9.

### Divide-By-Eight Decoder (Sine Wave Synthesiser)

IC6 is a divide-by-eight decoder. The outputs at Q1 to Q5 are progressively shifted 45 at each stage, and ripple through the counter with each clock pulse. Q4 is tied to the data input to provide a divide-by-eight function. The outputs are now at the CTCSS tone frequency. Q1 and Q3, which are in quadrature (90), set the centre frequency of the commutating filter.

### CTCSS Tone Encoder

Outputs Q1, Q2 & Q3 from IC6 are fed into the inputs of three exclusive OR gates (IC10). The other inputs to these gates are common and connect to gate output 2. A change at gate output 2 produces a phase inversion at the EXOR outputs, i.e. when gate output 2 releases, the encoder tone phase inverts for a short period (approx. 200ms) then returns to its original phase (RC time constant C37, C38 & R72).

The outputs of the exclusive OR gates are weighted and summed by resistors R37, R38 & R46. This signal is then filtered by a 3-pole active low pass filter. RV1 adjusts the level of tone output (tone deviation), speech high pass filter, tone low pass filter and the limiter.

Receiver or line audio is fed into the speech+tone input and is filtered for speech by two cascaded 3-pole active filters. The combined cut-off frequency is 400Hz -1.5dB. This effectively removes the CTCSS tone from the speech.

The CTCSS tones are filtered to remove speech by a 3-pole active filter with a cut-off frequency of 250Hz -1dB.

The filter output is amplified and limited and then applied to the commutating filter and synchronous detector.

The limiter also provides a bandpass function from 60 to 280Hz which reduces the effects of DC transients at the speech+tone input.

### Commutating Filter & Synchronous Detector

The commutating filter is a fixed bandwidth filter of ±2.8Hz. IC7 is a triple changeover switch. The input signal from the limiter is sampled via R35, C20 & C21 and R33, C18 & C19.

The sampling time and phase is obtained from the divide-by-eight decoder (IC6). When the sampling is the same frequency as the incoming tone frequency, a net charge is developed on each of the sampler capacitors. The charges which are in quadrature with respect to each other are then summed and the original signal is approximately reconstructed.

The limited input signal is also applied to a third changeover switch of IC7 which switches the inputs to IC9 pin 5 and R47.

When the reconstructed signal is negative (relative to bias voltage), the amplifier has positive gain, and when the signal is positive, it has negative gain. This produces inverted full wave rectification at IC9 pin 7 which is filtered by R50 and C28. D2 forms a positive clamp and Q2 a negative clamp to limit the excursions of the detected signal. This reduces the effect of ripple which occurs due to the small frequency difference that may exist between sampling signals and incoming tones.

### Threshold Detector

The rectified and filtered output is fed into a comparator with a threshold of approximately 0.35V (set by R53).

When a tone is detected, the output at IC9 pin 14 is “low”.

### Gate Output Logic

Two outputs are provided to either key a transmitter (gate output 2) or to mute a receiver (gate output 1) and an inhibit is provided if the received signal is not strong enough (Rx gate input). Defeat logic is also provided which enables the tone decoder to be bypassed for tests, etc. (i.e. earthing effectively removes decoder operation).

| Defeat | Rx Gate Input | Decoded Tone | Gate Out 2 | Gate Out 1 | Rx Mute | Tx |
|---|---|---|---|---|---|---|
| O.C | 0 | 0 | S.C | O.C | open | keyed |
| O.C | 0 | 1 | O.C | S.C | closed | off |
| O.C | 1 | 0 | O.C | S.C | closed | off |
| O.C | 1 | 1 | O.C | S.C | closed | off |
| 0 | 0 | 0 | S.C | O.C | open | keyed |
| 0 | 0 | 1 | S.C | O.C | open | keyed |
| 0 | 1 | 0 | O.C | S.C | closed | off |
| 0 | 1 | 1 | O.C | S.C | closed | off |

S.C = short circuit, O.C = open circuit

Control lines XOR, inhibit in and inhibit out, are not used in normal operation but are provided for use with two T800-02 units for dual tone operation (refer to page 9).

### Squelch Tail Elimination

When gate out 2 is released, the CTCSS tone output is inverted by the exclusive OR gates for a short period and then returns to its original phase (RC time constant formed by C37, C38 and R72 at approx. 200ms). The T800 Series I transmitter tail time must be set for an appropriate time of less than 200ms (normally approx. 80ms; refer to the appropriate T800 Series I Service Manual). This causes a reverse phase burst of CTCSS tone on the transmitter tail which causes mobile receivers to mute faster than normal, thus removing most of the squelch noise burst.

### Reverse Phase Burst

This function can be disabled by removing R71 (zero Ohm link resistor) from the T800-02 PCB. Note that this will result in the loss of the +9V pull-up to the output at S8.

# Parts List (IPN 225-01202-03)

| Ref | IPN | Description |
|---|---|---|
| C1 | 015-22470-01 | CAP CER 0805 CHIP 47P 5% NPO 50V |
| C1A | 015-21820-01 | CAP CER 0805 CHIP 8P2 +/-0.25P NPO 50V |
| C2 | 015-06100-08 | CAP CER 1206 CHIP 100N 10% X7R 50V |
| C3 | 015-23100-01 | CAP CER 0805 CHIP 100P 5% NPO 50V |
| C4 | 016-07100-01 | CAP ELECT 6X4MM CHIP 1M 20% 16V |
| C5 | 015-25100-08 | CAP CER 0805 CHIP 10N 10% X7R 50V |
| C6 | 015-25100-08 | CAP CER 0805 CHIP 10N 10% X7R 50V |
| C7 | 015-25100-08 | CAP CER 0805 CHIP 10N 10% X7R 50V |
| C8 | 015-25100-08 | CAP CER 0805 CHIP 10N 10% X7R 50V |
| C9 | 015-25100-08 | CAP CER 0805 CHIP 10N 10% X7R 50V |
| C10 | 015-25100-08 | CAP CER 0805 CHIP 10N 10% X7R 50V |
| C11 | 016-08100-01 | CAP ELECT 6X4MM CHIP 10M 20% 16V |
| C12 | 015-25100-08 | CAP CER 0805 CHIP 10N 10% X7R 50V |
| C13 | 015-25100-08 | CAP CER 0805 CHIP 10N 10% X7R 50V |
| C14 | 015-23220-01 | CAP CER 0805 CHIP 220P 5% NPO 50V |
| C15 | 015-05220-08 | CAP CER 1206 CHIP 22N 10% X7R 50V |
| C16 | 015-05470-08 | CAP CER 1206 CHIP 47N 10% X7R 50V |
| C17 | 016-07100-01 | CAP ELECT 6X4MM CHIP 1M 20% 16V |
| C18 | 016-07100-01 | CAP ELECT 6X4MM CHIP 1M 20% 16V |
| C19 | 016-07100-01 | CAP ELECT 6X4MM CHIP 1M 20% 16V |
| C20 | 016-07100-01 | CAP ELECT 6X4MM CHIP 1M 20% 16V |
| C21 | 016-07100-01 | CAP ELECT 6X4MM CHIP 1M 20% 16V |
| C22 | 015-25100-08 | CAP CER 0805 CHIP 10N 10% X7R 50V |
| C23 | 015-05220-08 | CAP CER 1206 CHIP 22N 10% X7R 50V |
| C24 | 015-05470-08 | CAP CER 1206 CHIP 47N 10% X7R 50V |
| C25 | 015-23220-01 | CAP CER 0805 CHIP 220P 5% NPO 50V |
| C26 | 016-08100-01 | CAP ELECT 6X4MM CHIP 10M 20% 16V |
| C27 | 016-08100-01 | CAP ELECT 6X4MM CHIP 10M 20% 16V |
| C28 | 016-08100-01 | CAP ELECT 6X4MM CHIP 10M 20% 16V |
| C29 | 016-08470-01 | CAP ELECT SMD 6*4MM 47U 16V |
| C30 | 016-08470-01 | CAP ELECT SMD 6*4MM 47U 16V |
| C31 | 015-25100-08 | CAP CER 0805 CHIP 10N 10% X7R 50V |
| C32 | 015-05220-08 | CAP CER 1206 CHIP 22N 10% X7R 50V |
| C33 | 015-05220-08 | CAP CER 1206 CHIP 22N 10% X7R 50V |
| C34 | 015-06100-08 | CAP CER 1206 CHIP 100N 10% X7R 50V |
| C35 | 015-06100-08 | CAP CER 1206 CHIP 100N 10% X7R 50V |
| C36 | 015-23680-08 | CAP CER 0805 CHIP 680P 10% X7R 50V |
| C37 | 015-06100-08 | CAP CER 1206 CHIP 100N 10% X7R 50V |
| C38 | 015-06100-08 | CAP CER 1206 CHIP 100N 10% X7R 50V |
| C39 | 015-25150-08 | CAP CER 0805 CHIP 15N 10% X7R 50V |
| D** | 001-50012-05 | (S) DIODE AI 1N4531 SI SMALL SIG |
| D* | 001-50012-05 | (S) DIODE AI 1N4531 SI SMALL SIG |
| D1 | 001-10000-70 | (S) DIODE SMD BAV70 DUAL SWITCH SOT-23 COMM CATHDE |
| D2 | 001-10000-70 | (S) DIODE SMD BAV70 DUAL SWITCH SOT-23 COMM CATHDE |
| IC1 | 002-10040-46 | (S) IC 4046 SMD PHASE LOCK LOOP |
| IC2 | 002-10040-18 | (S) IC 4018 SMD DEVIDE BY N COUNTER |
| IC3 | 002-10040-69 | (S) IC 4069 SMD CMOS HEX INVERTERS |
| IC4 | 002-10045-26 | (S) IC 4526 SMD PRESET 4BIT DWN CNTR |
| IC5 | 002-10045-69 | (S) IC 4569 SMD DUAL 4BIT DWN CNTR |
| IC6 | 002-10040-18 | (S) IC 4018 SMD DEVIDE BY N COUNTER |
| IC7 | 002-10040-53 | (S) IC 4053 SMD TRIPLE 2CH MULTI-PLEXR |
| IC8 | 002-10003-24 | (S) IC SMD 324 QUAD OP AMP SO14 |
| IC9 | 002-10003-24 | (S) IC SMD 324 QUAD OP AMP SO14 |
| IC10 | 002-10040-70 | (S) IC SMD HEF4070BT QUAD EXCL-OR SO-14 |
| PL1 | 240-00020-78 | HEADER 10 WAY RT ANGLE PCB MTG AMP ULTREX |
| Q1 | 000-10008-17 | (S) XSTR SMD BC817-25 NPN SOT-23 AF LO PWR |
| Q2 | 000-10008-48 | (S) XSTR SMD BCW60/BC848B215 NPN SOT23 |
| Q3 | 000-10008-48 | (S) XSTR SMD BCW60/BC848B215 NPN SOT23 A |
| Q4 | 000-10008-57 | (S) XSTR SMD BCW70/BC857-215 PNP SOT23 AF |
| Q5 | 000-10008-48 | (S) XSTR SMD BCW60/BC848B215 NPN SOT23 AF |
| Q6 | 000-10008-48 | (S) XSTR SMD BCW60/BC848B215 NPN SOT23 AF |
| R** | 030-55120-20 | RES FILM AI 12K 5% 0.4W 4X1.6MM |
| R* | 036-15100-00 | RES M/F 0805 CHIP 10K 5% |
| R1 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| RV1 | 042-15200-01 | RES PRESET SMD 20K +-25% 4X4.5X2.5MM 0.1W 50V |
| R2 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R3 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R4 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R5 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R6 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R7 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R8 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R9 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R10 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R11 | 036-16330-00 | RES M/F 0805 CHIP 330K 5% |
| R12 | 036-18100-00 | RES M/F 0805 CHIP 10M 10% |
| R13 | 036-15120-00 | RES M/F 0805 CHIP 12K 5% |
| R14 | 036-14100-00 | RES M/F 0805 CHIP 1K 5% |
| R15 | 036-15120-00 | RES M/F 0805 CHIP 12K 5% |
| R16 | 036-12470-00 | RES M/F 0805 CHIP 47E 5% |
| R17 | 036-14680-00 | RES M/F 0805 CHIP 6K8 5% |
| R18 | 036-15270-00 | RES M/F 0805 CHIP 27K 5% |
| R19 | 036-16390-00 | RES M/F 0805 CHIP 390K 5% |
| R20 | 036-15270-00 | RES M/F 0805 CHIP 27K 5% |
| R21 | 036-15100-00 | RES M/F 0805 CHIP 10K 5% |
| R22 | 036-14680-00 | RES M/F 0805 CHIP 6K8 5% |
| R23 | 036-16390-00 | RES M/F 0805 CHIP 390K 5% |
| R24 | 036-14100-00 | RES M/F 0805 CHIP 1K 5% |
| R25 | 036-13680-00 | RES M/F 0805 CHIP 680E 5% |
| R26 | 036-14270-00 | RES M/F 0805 CHIP 2K7 5% |
| R27 | 036-16150-00 | RES M/F 0805 CHIP 150K 5% |
| R28 | 036-16150-00 | RES M/F 0805 CHIP 150K 5% |
| R29 | 036-16150-00 | RES M/F 0805 CHIP 150K 5% |
| R30 | 036-15100-00 | RES M/F 0805 CHIP 10K 5% |
| R31 | 036-16820-00 | RES M/F 0805 CHIP 820K 5% |
| R32 | 036-16330-00 | RES M/F 0805 CHIP 330K 5% |
| R33 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R34 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R35 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R36 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R37 | 036-15330-00 | RES M/F 0805 CHIP 33K 5% |
| R38 | 036-15470-00 | RES M/F 0805 CHIP 47K 5% |
| R39 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R40 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R41 | 036-16150-00 | RES M/F 0805 CHIP 150K 5% |
| R42 | 036-16150-00 | RES M/F 0805 CHIP 150K 5% |
| R43 | 036-16150-00 | RES M/F 0805 CHIP 150K 5% |
| R44 | 036-14470-00 | RES M/F 0805 CHIP 4K7 5% |
| R45 | 036-13680-00 | RES M/F 0805 CHIP 680E 5% |
| R46 | 036-15470-00 | RES M/F 0805 CHIP 47K 5% |
| R47 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R48 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R49 | 036-16150-00 | RES M/F 0805 CHIP 150K 5% |
| R50 | 036-15100-00 | RES M/F 0805 CHIP 10K 5% |
| R51 | 036-15100-00 | RES M/F 0805 CHIP 10K 5% |
| R52 | 036-15100-00 | RES M/F 0805 CHIP 10K 5% |
| R53 | 036-13680-00 | RES M/F 0805 CHIP 680E 5% |
| R54 | 036-14680-00 | RES M/F 0805 CHIP 6K8 5% |
| R55 | 036-17100-00 | RES M/F 0805 CHIP 1M 5% |
| R56 | 036-15150-00 | RES M/F 0805 CHIP 15K 5% |
| R57 | 036-15100-00 | RES M/F 0805 CHIP 10K 5% |
| R58 | 036-16330-00 | RES M/F 0805 CHIP 330K 5% |
| R60 | 036-14220-00 | RES M/F 0805 CHIP 2K2 5% |
| R61 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R62 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R63 | 036-15100-00 | RES M/F 0805 CHIP 10K 5% |
| R64 | 036-16820-00 | RES M/F 0805 CHIP 820K 5% |
| R65 | 036-14680-00 | RES M/F 0805 CHIP 6K8 5% |
| R66 | 036-15150-00 | RES M/F 0805 CHIP 15K 5% |
| R67 | 036-14220-00 | RES M/F 0805 CHIP 2K2 5% |
| R68 | 036-15180-00 | RES M/F 0805 CHIP 18K 5% |
| R69 | 036-15100-00 | RES M/F 0805 CHIP 10K 5% |
| R70 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R71 | 036-10000-00 | RES M/F 0805 CHIP ZERO OHM |
| R72 | 036-17100-00 | RES M/F 0805 CHIP 1M 5% |
| R73 | 036-17100-00 | RES M/F 0805 CHIP 1M 5% |
| R74 | 036-15470-00 | RES M/F 0805 CHIP 47K 5% |
| R75 | 036-15680-00 | RES M/F 0805 CHIP 68K 5% |
| R76 | 036-14470-00 | RES M/F 0805 CHIP 4K7 5% |
| R77 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R78 | 036-16100-00 | RES M/F 0805 CHIP 100K 5% |
| R79 | 036-17100-00 | RES M/F 0805 CHIP 1M 5% |
| R80 | 036-15330-00 | RES M/F 0805 CHIP 33K 5% |
| SW1 | 230-10010-20 | SWITCH DIP SMD 10-WAY |
| X1 | 274-00010-05 | XTAL 32.768KHZ SUB MINI CLOCK C/W TEFLON INS |
| | 201-00030-01 | WIRE #1 T/C WIRE 7/0.2MM PVC BROWN |
| | 201-00030-02 | WIRE #1 T/C WIRE 7/0.2MM PVC RED |
| | 201-00030-03 | WIRE #1 T/C WIRE 7/0.2MM PVC ORANGE |
| | 201-00030-04 | WIRE #1 T/C WIRE 7/0.2MM PVC YELLOW |
| | 201-00030-05 | WIRE #1 T/C WIRE 7/0.2MM PVC GREEN |
| | 201-00030-06 | WIRE #1 T/C WIRE 7/0.2MM PVC BLUE |
| | 201-00030-07 | WIRE #1 T/C WIRE 7/0.2MM PVC VIOLET |
| | 201-00030-08 | WIRE #1 T/C WIRE 7/0.2MM PVC GREY |
| | 201-00030-09 | WIRE #1 T/C WIRE 7/0.2MM PVC WHITE |
| | 201-00030-10 | WIRE #1 T/C WIRE 7/0.2MM PVC BLACK |
| | 225-01202-03 | PCB T800 CTCSS DE-ENCODER |
| | 240-04020-76 | SKT RECEPTACLES WIRE CRIMP FOR ULTREX HOUSING |
| | 240-04020-80 | SKT HOUSING 10 WAY CORD MTG ULTREX |
| | 303-50078-00 | CLIP A4M2630 0.1MM SPRING WIRE CABLE CLAMP |
| | 349-00020-32 | SCREW TAPTITE M3X8MM PAN POZI BZ |
| | 365-00011-38 | LABEL STATIC WARNING YELLOW A4A315 |
| | 365-00011-54 | LABEL WHITE RW1556/2 90*24MM |
| | 369-00010-27 | TIE CABLE NYLON 140*2.6MM |
| | 399-00010-51 | BAG PLASTIC 75*100MM |
| | 399-00010-86 | BAG STATIC SHIELDING 127X203MM |
| | 410-00010-64 | PKG HEADER CARD A3M2392 |
| | 419-80200-00 | FITTNG INS T800-02 TO T800 SI |

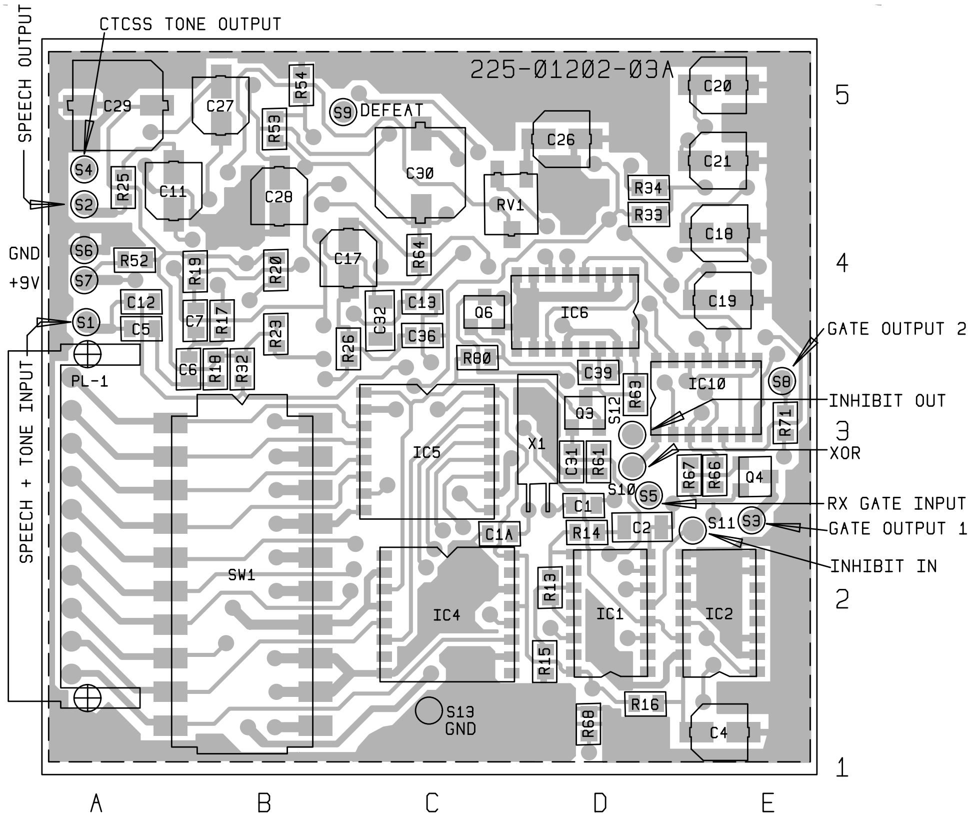


*Figure 15 T800-02 PCB Layout - Top Side (IPN 225-01202-03)*

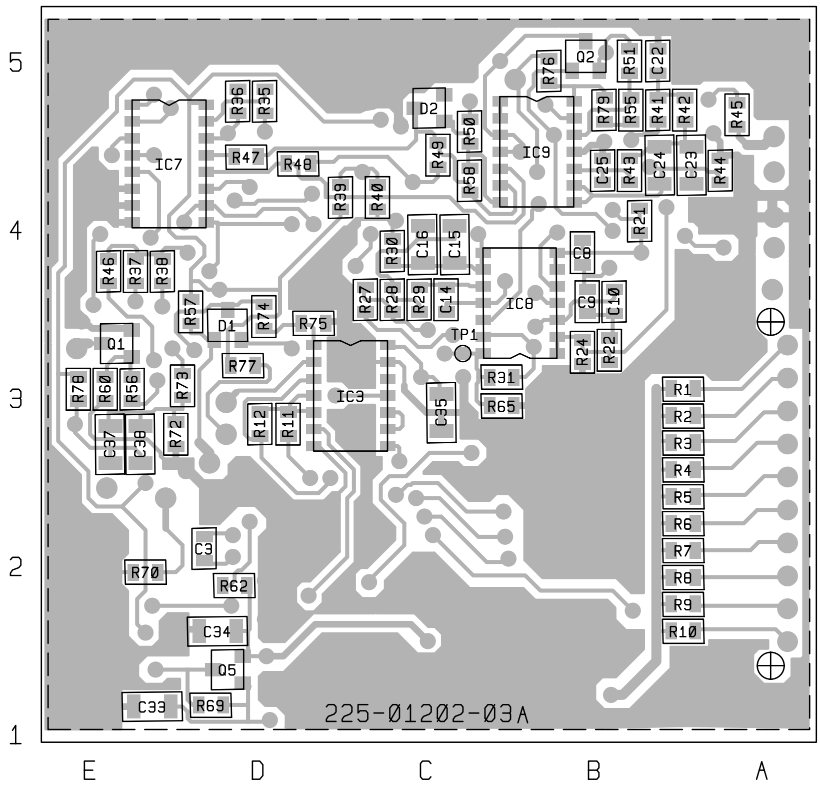


*Figure 16 T800-02 PCB Layout - Bottom Side (IPN 225-01202-03)*

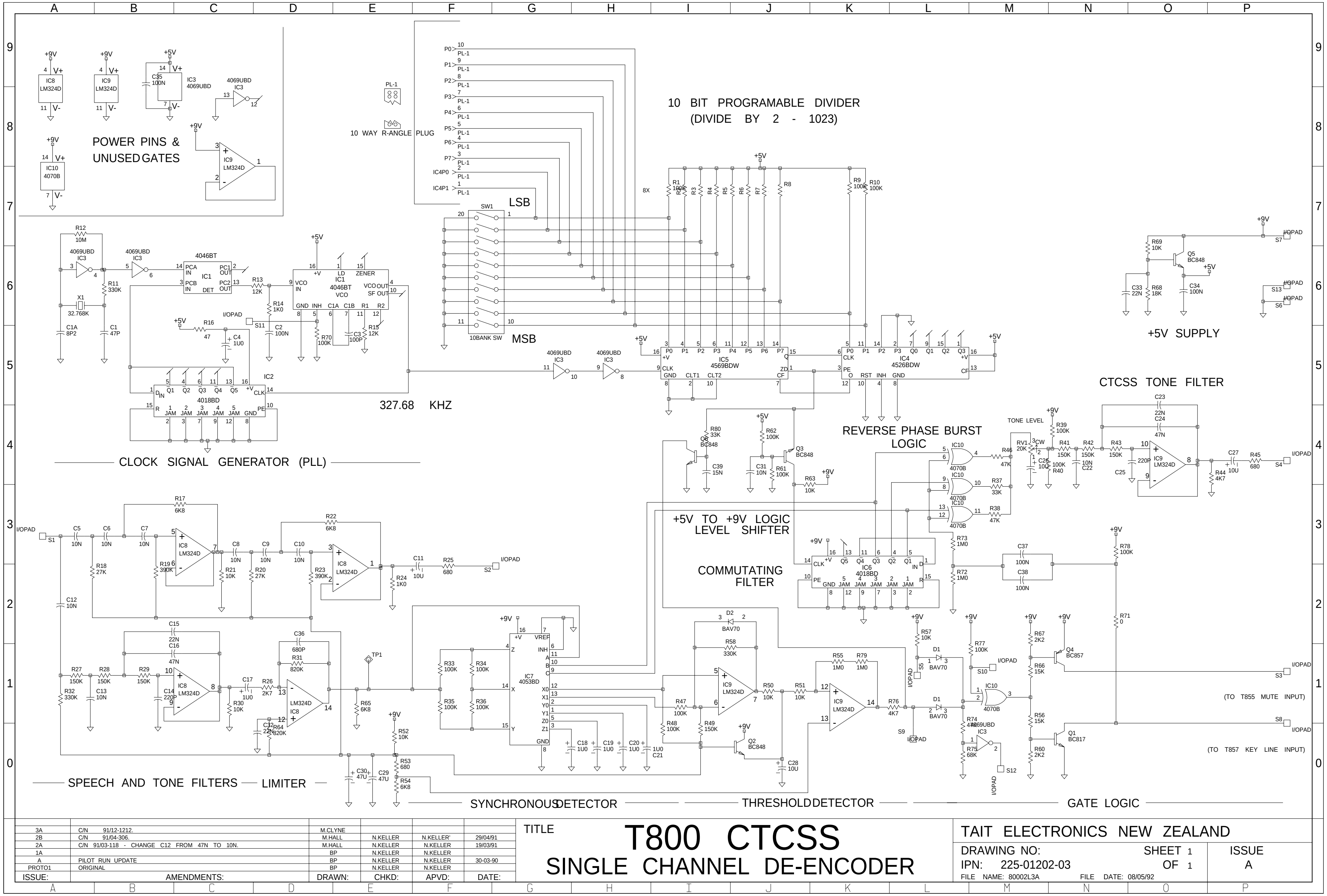


*Figure 17 T800-02 Circuit Diagram (IPN 225-01202-03)*

## Issuing Authority

This TN was issued by: Andreas Becker
RSD Customer Support Manager

## Publication History

| Publication Date | Author |
|---|---|
| 21st April 1999 | D Reynolds |

## Amendment Record

| Publication Date | Page | Amendment |
|---|---|---|
| 21st April 1999 | | TI-346D republished as TN-566. |
| | 1 | • “Applicability” section added<br>• “Introduction” paragraph 4 amended |
| | 2 | • “Note 2” added about T825 receivers<br>• “Note 3” added about removing C19 |
| | 6 | • “T800-02 board” replaced with “Talk Through PCB” |
| | 9 | • “detected“ replaced by “received” in paragraph 2<br>• Figure 10 corrected<br>• address details in paragraph 7 updated |
| | 18 | • “Reverse Phase Burst” section added |
| | 22 | • “Issuing Authority”, “Publication History” and “Amendment Record” sections added |