

2.9 T837 Exciter Drive Amplifier

FCC ID: CASTEL0006
EXCITER: 2.983 (10)

(Refer to Figure 2.2 and the exciter circuit diagram (sheet 3) in Section 6.3.)

A two-stage, wide band amplifier (Q365, Q370) provides an output level of approximately 800mW (+29dBm) for an input of 170mW (+22dBm) from the VCO. IC330 pins 5, 6 & 7, Q310, and Q315 provide a 10.5V regulated supply for the exciter.

To reduce the spurious output level when the synthesiser is out-of-lock, the Tx-Reg. and Lock-Detect signals are gated to inhibit the exciter control circuit and to switch off the RF signal at the input to the drive amplifier. This is achieved by a PIN switch attenuator (D340, D350, D360).

Cyclic keying control is provided by additional circuitry consisting of several time delay, ramp and gate stages:

- Q305, IC330 pins 5, 6 & 7 power ramping
- Q340, Q345 Tx-Reg. and Lock-Detect gate
- Q320, Q325, Q330, Q335 delay and PIN switch drive.

This is to allow the RF power circuits (both exciter and PA) to ramp up and down in a controlled manner so that minimal adjacent channel interference is generated during the transition.

R359, R360 and R362 form a 6dB attenuator to provide good VCO/drive amplifier isolation.

The output attenuator (R392, R390, R394, R396) assists in reducing exciter/PA interaction while also ensuring a good match for Q370.

Note: The exciter provides a DC control signal to the PA via the RF coax. This is injected via L390.

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T836/837 Initial Tuning & Adjustment

C3.5

3.4 Short Tuning Procedure

FCC ID: CASTEL0006
EXCITER: 2.983 (d)(9)

Use this procedure only if you want to reprogram the T836/837 to a frequency outside the 8MHz switching range and do not intend to carry out any other major adjustments or repairs.

3.4.1 Introduction

Reprogram the operating frequency as described in the PGM800Win programming kit (refer to Section 3.2).

Remove the top cover (nearest the handle).

Set up the test equipment as described in Section 3.3.

Set the links in the audio processor section as required (refer to Section 3.5).

3.4.2 Synthesiser Alignment

- Connect a high impedance voltmeter to PL4-1 or the junction of L1 & R1 in the VCO (this measures the synthesiser loop voltage).
- Key the transmitter by earthing the Tx-Key line.
- | | |
|----------------|---|
| Single Channel | Tune VCO trimmer CV1 for a synthesiser loop voltage of 9V. |
| Multichannel | Tune VCO trimmer CV1 for a synthesiser loop voltage of 9V on the middle channel.

If there is no middle channel, tune CV1 so that the channels are symmetrically placed around a loop voltage of 9V.

All channels should lie within the upper and lower limits of 13V and 5V respectively.

Do not attempt to program channels with a greater frequency separation than the specified switching range of 8MHz. |

3.4.3 Output Power Adjustment (T836 Only)

Connect an RF power meter to the output socket and key the transmitter.

Turn RV320 (power adjust) fully clockwise.

Tune CV451 (output power trim) for maximum output power and check that this is >30W.

Adjust RV320 for the required output power (between 5 and 25W).

Readjust CV451 to reduce the supply current by up to 0.5A.

C3.6 T836/837 Initial Tuning & Adjustment

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3.4.4 Two Point Modulation Adjustment

Note 1: In this and following sections deviation settings are given first for wide bandwidth sets, followed by settings in brackets for mid bandwidth sets () and narrow bandwidth sets [].

Note 2: Reference modulation and limiter adjustment are controlled by PGM800Win. Electronic potentiometers (256 step) are used to allow channel-by-channel adjustment of deviation and two point modulation.

Note 3: To optimise the modulation response across the switching range, repeat steps 1-4 below for each channel that will be used (usually needed only for data applications). In applications where the modulation response is less critical (e.g. voice use only), carry out steps 1-4 below on the middle channel and cut and paste the value to all other channels.

1. Inject an audio signal of 600Hz 1.5V rms (+5dBm) into the CTCSS input (D-range 1 (PL100) pin 8).
Key the transmitter by earthing the Tx-Key line.
2. Adjust the output from the audio generator to obtain $\pm 3\text{kHz}$ ($\pm 2.4\text{kHz}$) [$\pm 1.5\text{kHz}$] deviation at 600Hz.
3. Change the input frequency to 120Hz and adjust "reference modulation" via PGM800Win to obtain $\pm 3\text{kHz}$ ($\pm 2.4\text{kHz}$) [$\pm 1.5\text{kHz}$] deviation (you can use either the mouse or up and down arrow keys).
4. Change the input frequency back to 600Hz.
Repeat steps 2 and 3 above until the deviations achieved at the two input frequencies are within 0.2dB of each other. You will need to do this at least four times.
5. Sweep the audio between 50 and 300Hz for peaks.

Note: A peak between 50 and 300Hz will indicate a fault condition, i.e:
- incorrect set-up
or - modulation circuitry fault.

The specification window is $\pm 1\text{dB}$ relative to 150Hz from 65 to 260Hz.

3.4.5 FM Deviation (Limiter) Adjustment

Note: If the T836/837 will be used over the whole 8MHz switching range, you must set the deviation for each channel. However, if the module will be used on frequencies that cover only a 1MHz (or less) switching range, you can set the deviation on the middle channel and use this value for all other channels with the "fill" option in PGM800Win.

Inject 1kHz at -10dBm into the line input (D-range 1 (PL100) pins 1 & 4; pins 2 & 3 shorted; refer to Section 2.2 of Part F).

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T836/837 Initial Tuning & Adjustment**C3.7**

Adjust RV210 (line sensitivity) fully clockwise and key the transmitter by earthing the Tx-Key line. Adjust "deviation" via PGM800Win to set the peak deviation to $\pm 4.7\text{kHz}$ ($\pm 3.8\text{kHz}$) [$\pm 2.3\text{kHz}$] (you can use either the mouse or up and down arrow keys).

Sweep the audio frequency from 100Hz to 4kHz and ensure that the maximum deviation does not exceed 4.7kHz ($\pm 3.8\text{kHz}$) [$\pm 2.3\text{kHz}$]. Readjust "deviation" if necessary via PGM800Win.

3.4.6 Line-in Level Adjustment

Set the injected signal at the line input to the required line level (typically -10 to -20dBm).

Adjust RV210 (line sensitivity) to provide $\pm 3\text{kHz}$ ($\pm 2.4\text{kHz}$) [$\pm 1.5\text{kHz}$] deviation.

T830 Series II Base Station Equipment Service Manual

Preliminary Issue

August 1997

(Not For Resale)

About This Manual

Scope

This manual contains preliminary servicing information on T830 Series II 25W, 50W and 100W base stations which comprise the following equipment:

25W base station	T835 receiver T836 25W transmitter
50W base station	T835 receiver T837 exciter T838 50W power amplifier
100W base station	T835 receiver T837 exciter T839 100W power amplifier

Contents

Part A contains information on the following procedures:

- changing the operating frequency
- retuning the module after changing frequency
- configuring the audio processor
- T838/839 user information

Parts B to G contain the following PCB information:

- parts lists
- grid reference indexes
- PCB layout diagrams
- test points & options diagrams
- circuit diagrams

Part H contains the following information on the T800-22-0000 rack frame:

- general information
- circuit operation
- parts lists
- PCB layout diagrams

Technical Information

Any enquiries regarding this manual or the equipment it describes should be addressed in the first instance to your nearest approved Tait Dealer or Service Centre. Further technical assistance and copies of this manual may be obtained from the Customer Support Group, Radio Infrastructure Division, Tait Electronics Ltd, Christchurch, New Zealand.

Date Of Issue

T830 Series II Preliminary Service Manual published August 1997



Changing the Operating Frequency of the T800 Series//

Overview

Introduction

When you receive the T800 module it will be run up and working on a particular frequency. Sometimes you may want to change the operating frequency. In some cases, when you change the operating frequency, it will also be necessary to re-tune the radio to ensure correct operation.

Purpose of this document

It is the purpose of this document to familiarise you with the procedures that must be carried out to check that the radio is still operating correctly, and how to re-tune the radio when this is not the case.

In this section

This section covers the following topics:

Topic	See page
How to change the operating frequency	2
How to re-tune the T835	4
How to re-tune the T836/837	7
Configuring the Audio Processor	11
How to determine if the T835/836/837 is still operating	16



Changing the Operating Frequency of the T800 SeriesII

Example

A T830 receiver has been tuned optimally for 460MHz. Therefore, it's switching range is 460-1.5MHz to 460+1.5MHz. i.e. 458.5MHz to 461.5MHz.



Changing the Operating Frequency of the T800 Series//

How to re-tune the T835 cont..

Steps involved

The service manual has a section which describes a full Initial Tuning and Adjustment procedure. This must be used if a repair has been made or some other major characteristic has been changed. If the only adjustment made has been to switch to a channel outside the switching band, then the following steps should be followed.

- Change the operating frequency
- Lock the VCO
- Align the front end
- Set the noise mute
- Set the line output level

The procedure is described below.

Procedure

Follow the steps below to retune the T835 if the frequency has been changed and the radio stops operating.

Step	Action
Lock the VCO	
1	Connect a high impedance voltmeter to the long lead of L1 in the VCO (this measures the synthesiser loop voltage).
2	Single channel Tune VCO trimmer C6 for a synthesiser loop voltage of 10V. Multichannel Tune VCO trimmer C6 for a synthesiser loop voltage of 10V on the middle channel. If there is no middle channel, tune C6 so that the channels are symmetrically placed around a loop voltage of 10V. All channels should lie within the upper and lower limits of 16V and 3V respectively. Do not attempt to programme channels with a greater frequency separation than the specified switching range.



Changing the Operating Frequency of the T800 Series II

How to re-tune the T836/837

Equipment required

You will need:

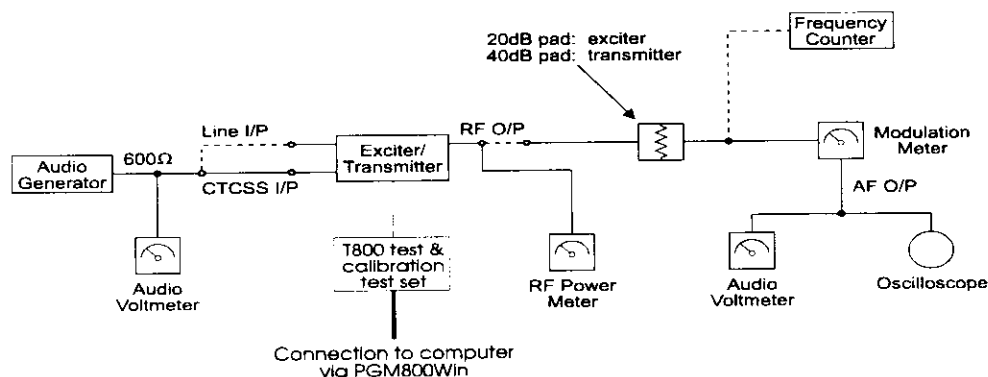
Computer with PGM800Win installed
T800 programming kit
T800 test & calibration unit
Digital multimeter
Oscilloscope (digital preferred)
Audio signal generator
Audio voltmeter x 2
RF power meter
Modulation meter
20dB pad

or

Computer with PGM800Win installed
T800 programming kit
T800 test & calibration unit
RF test set

Before you start

- Remove the top cover of the module (the side closest to the handle).
- Set up the test equipment as shown below.



- Set the jumpers in the audio section of the module as required (see section "Configurrging the Audio Processor").
- Connect the computer to the module using the PGM800Win programming kit.



Changing the Operating Frequency of the T800 SeriesII

Adjust the Output power (T856 only)	
1	Connect an RF power meter to the output socket and key the transmitter
2	Set power control RV320 fully clockwise
3	Adjust CV451 for maximum output power and check that this exceeds 30W
4	Adjust power control RV320 for required power output
5	Readjust CV451 to reduce the supply current by up to 0.5A.
Set the dual point modulation (to maximise the modulation response). Settings are first given for wide band sets, followed in brackets by settings for narrow band []	
Multiple channels	- To optimise the modulation response across the switching band repeat steps 1-4 for each channel that will be used (usually only needed for data applications). - For usage where the modulation response is less critical (e.g. voice use only) follow steps 1-4 on the middle channel and then cut and paste the value for all other channels.
1	Inject an audio signal of 600Hz 1.5Vrms (+5dBm) into the CTCSS input (D-range pin 8). Key the transmitter.
2	Adjust the output from the audio generator to obtain +/-3kHz [+/-1.5kHz] deviation at 600Hz.
3	Change the input frequency to 120Hz and using PGM800Win, adjust the "Reference modulation" (by using the mouse or up and down arrow keys) to obtain +/-3kHz [+/-1.5kHz] deviation.
4	Change the input frequency back to 600Hz. Repeat steps 2 and 3 above until the deviations achieved at the two input frequencies are within 0.2dB of each other. This will need to be done at least four time.
5	Sweep the audio between 50 and 300Hz for peaks. A peak indicates a fault condition (incorrect setup or modulation circuitry fault). The specification window is +/-1dB relative to 150Hz from 65 to 260Hz.



Changing the Operating Frequency of the T800 SeriesII

Configuring the Audio Processor

Introduction

There are a number of links in the T835, 836 & T837 that can be changed to configure the audio processor in various ways. The linking options are given below for each of the T830 modules followed by a block diagram of the audio processor and link configurations.

T835 audio processor links

Use the table below to set up the audio processor as you require it.

General

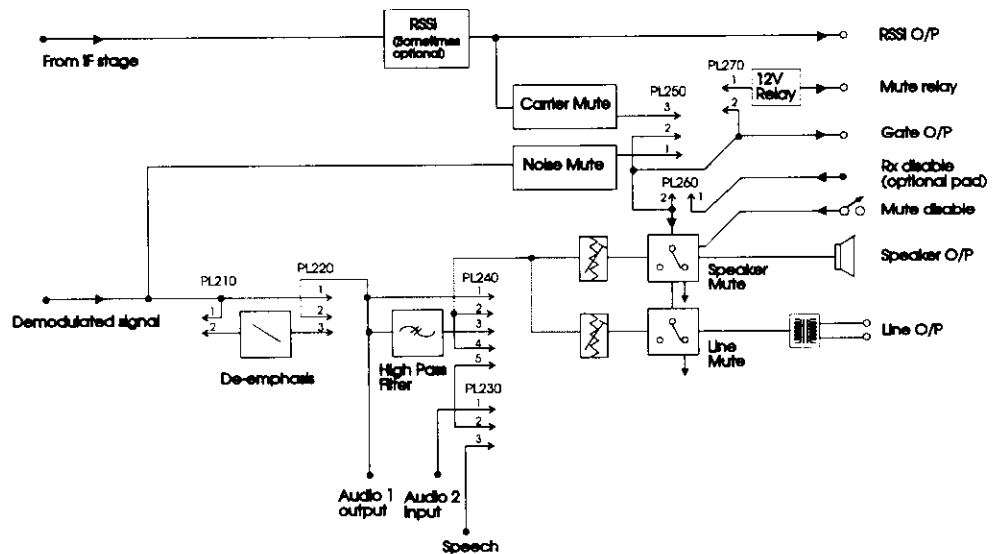
Plug	Link	Function
PL210	1 - 2 2 - 3	de-emphasised response flat response
PL220	1 - 2 2 - 3	flat response de-emphasised response
PL230	1 - 2 2 - 3 3 - 4	audio input via audio 2 pad audio from internal CTCSS speech filter audio input via I/O pad P250
PL240	1 - 2 2 - 3 or 3 - 4 4 - 5	bypass high pass filter 300Hz high pass filter in circuit audio input via PL230 or I/O pad P250
PL250	1 - 2 2 - 3	noise mute carrier mute
PL260	1 - 2 2 - 3	Rx disable link not connected
PL270	1 - 2 2 - 3	relay link not connected
Options should be selected before alignment of the receiver is attempted.		



Changing the Operating Frequency of the T800 SeriesII

Note:

- 1) Audio 2 is available via D range connector PL100 Pin7 via the link resistor R160. PL100 Pin7 is already assigned to serial com. but this can be disabled by removing R808.
- 2) External CTCSS units can be connected in series with audio via Audio 1 and Audio 2.



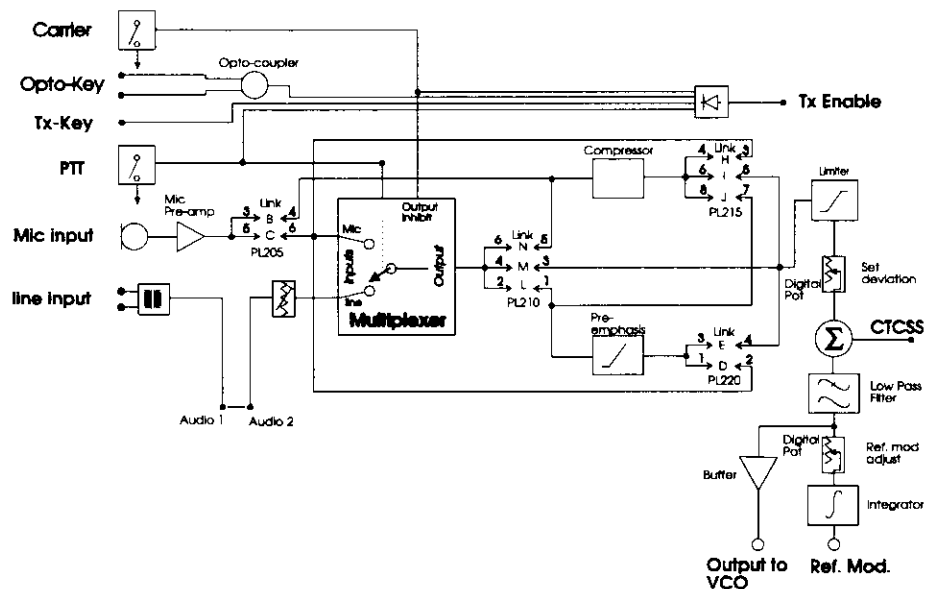
T835 Audio processor block diagram showing link options



Changing the Operating Frequency of the T800 SeriesII

Configuring the Audio Processor cont..

T836/T837 audio processor links cont..



T836/837 Audio processor block diagram showing link options



Operating the power amplifiers

Introduction

The T838/839 power amplifiers are designed to operate at 50 Watts and 100 Watts respectively at ambient temperatures up to 60 degC. Operation at higher power or higher temperature will result in decreased service life.

We have designed two safeguards into the equipment. Please read about them below and note the warning when you install the equipment.

Equipment safeguards.

Maximum power clamp

This is to prevent over-dissipation in the power modules resulting in excess temperature rise. The level is factory preset and should not need field adjustment.

Warning: Should adjustment be necessary you must follow the procedure outlined next to prevent damage to the module. Turn front panel power control up full, adjust clamp potentiometer for 120W (T839) 60W (T838) and readjust front panel power control for 100W (T839) 50W (T838).

Multi point temperature sensed power turn down

In addition to the usual temperature sensor that controls the fan (T839), the heat-sink temperature of each power module is also sensed. Should the temperature rise excessively, by mis-adjustment or poor airflow, the output power will automatically reduce until the temperature is reduced.

Important

In all installations it is important to ensure good airflow to ensure ambient temperature does not exceed 60 degC on any units in the rack. Rack mounted fans are recommended, particularly where several channels are installed in one cabinet.



How to determine if the T835/836/837 is still operating

Introduction

If the radio was working fine and you want to check that it is still operating correctly, after changing the operating frequency, follow the steps listed below.

Procedure

Follow the steps below to perform a quick check of correct operation.

Step	Action
1	Remove the top cover of the module (the side closest to the handle).
2	Connect a high impedance voltmeter to the long lead of L1 in the VCO (this measures the synthesiser loop voltage).
3	Ensure the measured DC voltage is between 5 & 15V

Note: If the T835 Receiver is not operating this will be indicated by a slow flashing of the Green Supply light. This should be used as a visual check followed by the more definitive check given above.



Configuring the Audio Processor cont..

T836/T837 audio processor links

Use the table below to set up the audio processor as you require it.

General

Plug	Link	Function
PL205	(A) 1 - 2 (B) 3 - 4 (C) 5 - 6	not connected microphone pre-amp. output to compressor input microphone pre-amp. output to multiplexer input
PL210	(L) 1 - 2 (M) 3 - 4 (N) 5 - 6	multiplexer output to pre-emphasis input multiplexer output to limiter input multiplexer output to compressor input
PL215	(G) 1 - 2 (H) 3 - 4 (I) 5 - 6 (J) 7 - 8 (K) 9 - 10	not connected compressor output to multiplexer input compressor output to limiter input compressor output to pre-emphasis input not connected
PL220	(D) 1 - 2 (E) 3 - 4 (F) 5 - 6	pre-emphasis output to multiplexer input pre-emphasis output to limiter input not connected

Typical options

	PL205	PL210	PL215	PL220
microphone pre-amp. compressed and pre-emphasised; line input pre-emphasised (standard set-up)	(B) 3 - 4	(L) 1 - 2	(H) 3 - 4	(E) 3 - 4
microphone pre-amp. compressed and pre-emphasised; line input unprocessed	(B) 3 - 4	(M) 3 - 4	(J) 7 - 8	(D) 1 - 2
line and microphone compressed and pre-emphasised	(C) 5 - 6	(N) 5 - 6	(J) 7 - 8	(E) 3 - 4
microphone pre-amp compressed; line and microphone flat response;	(B) 3 - 4	(M) 3 - 4	(H) 3 - 4	(F) 5 - 6



Configuring the Audio Processor cont..

T835 audio processor links cont..

For CTCSS

The audio processor links must be appropriately connected for the CTCSS option used as shown in the table below.

CTCSS Option	PL230	PL240
standard, no CTCSS	2 - 3	2 - 3
received CTCSS tone + speech to line output	3 - 4	1 - 2
high pass filtered speech + internal CTCSS detection	2 - 3	4 - 5
external CTCSS detection	1 - 2	4 - 5

The conditions stated in the above table are defined as follows:

standard, no CTCSS

- no CTCSS or other sub-audio signalling used
- audio bandwidth 300Hz to 3kHz
- hum & noise -55dB

received CTCSS + speech to line output

- tone and speech transmitted down 600 ohm line
- audio bandwidth 10Hz to 3kHz
- hum & noise -45dB

high pass filtered speech + internal CTCSS detection

- decoding performed in receiver
- audio bandwidth 400Hz to 3kHz
- hum & noise -30dB with 250.3Hz tone present

external CTCSS

- decoding performed through the receiver (but externally) by T310-05 or similar
- speech injected back into receiver via "audio 2" and sent down 600 ohm line



Changing the Operating Frequency of the T800 Series II

Set the FM deviation (limiter adjustment)	
1	Inject 1kHz at -10dBm into the line input (D-range pins 1 & 4; pins 2 & 3 shorted).
2	Adjust RV210 (line sensitivity) fully clockwise and earth the key line. Using PGM800Win, adjust the "Deviation" (by using the mouse or up and down arrow keys) to set the peak deviation to +/-4.7kHz [$\pm$ 2.3kHz].
3	Sweep the audio frequency from 100Hz to 4kHz and ensure that the maximum deviation does not exceed 4.7kHz [2.3kHz]. Re-adjust "Deviation" if necessary. Note: • If the radio is to be used over the whole switching bandwidth (8MHz) the deviation should be set for each channel. • If the frequencies to be switched over is less than 1MHz then the deviation can be set on the middle channel and this value used for all other channels using the "fill" option in PGM800Win.
Reset the line-in level	
1	Set the injected signal at the line input to the required line level (typically -10 to -20dBm).
2	Adjust RV210 (line sensitivity) to provide +/-3kHz [$\pm$ 1.5kHz] deviation.



How to re-tune the T836/837 cont..

Steps involved

The service manual has a section which describes a full Initial Tuning and Adjustment procedure. This must be used if a repair has been made or some other major characteristic has been changed. If the only adjustment made has been to switch to a channel outside the switching band, then the following steps should be followed.

- Change the operating frequency
- Lock the VCO to produce the output frequency
- Adjust the output power
- Set the dual point modulation
- Set the FM deviation
- Reset the line-in level

The procedure is described below.

Procedure

Follow the steps below to retune the T836 or T837 if the frequency has been changed and the radio stops operating.

Step	Action
Lock the VCO to produce the output frequency	
1	Connect a high impedance voltmeter to the long lead of L1 in the VCO (this measures the synthesiser loop voltage).
2	Single channel Tune VCO trimmer C6 for a synthesiser loop voltage of 10V. Multichannel Tune VCO trimmer C6 for a synthesiser loop voltage of 10V on the middle channel. If there is no middle channel, tune C6 so that the channels are symmetrically placed around a loop voltage of 10V. All channels should lie within the upper and lower limits of 16V and 3V respectively. Do not attempt to programme channels with a greater frequency separation than the specified switching range.



Changing the Operating Frequency of the T800 Series II

Align the front end

Settings are first given for wide band sets, followed in brackets by settings for narrow band []. For multichannel operation the receiver should be aligned on a middle frequency.

Fre- quency range	136-156MHz: With the power supply switched off, solder bridge links SL405, 410, 415, 430, 435, 440 and link B in the front end 148-174MHz: Solder bridge link A and ensure links SL405, 410, 415, 430, 435, 440 linkB are not connected.
1	Inject a strong on-channel RF signal with 3kHz deviation [1.5kHz] at 1kHz into the antenna socket and adjust L410, L420, L460 & L470 to give best sinad.
2	Continually decrease the RF level to maintain 12dB SINAD.
3	Readjust the front end doublets (L410, L420, L460 & L470 to give best sinad.
4	The receiver sensitivity should be better than -117dBm, assuming that the audio levels are not being overdriven (refer to Line Amplifier Output below).

Set the noise mute

1	Connect pins 1&2 of PL250 to enable the noise mute.
2	Set the RF level to -105dBm with 3kHz deviation [1.5kHz] at 1kHz.
3	Set RV230 (gate sensitivity) fully anticlockwise.
4	Adjust RV330 to close the mute (if necessary turn off the RF signal and then turn it on again).
5	Rotate RV330 anticlockwise until the mute just opens.
6	Adjust RV230 (gate sensitivity) on the front panel for the required opening sinad.

Set the line output level

1	Apply an on-channel signal from the RF generator at a level of -70dBm with 3kHz deviation [1.5kHz] at 1kHz.
2	Adjust the front panel line level pot. (RV210) to give an output of +10dBm on the 600 ohm line.
3	Set the line level to the required output level.



How to re-tune the T835

Equipment required

You will need:

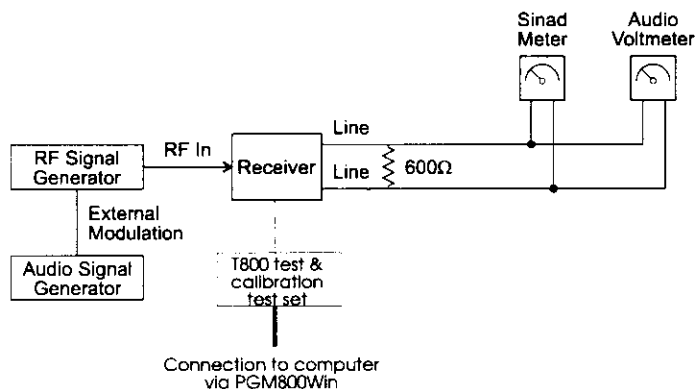
Computer with PGM800Win installed
T800 programming kit
T800 test & calibration unit
Digital multimeter
Audio signal generator
RF signal generator
Audio voltmeter
Sinad meter

or

Computer with PGM800Win installed
T800 programming kit
T800 test & calibration unit
RF test set

Before you start

- Remove the top cover of the module (the side closest to the handle).
- Set up the test equipment as shown below.



- Set the jumpers in the audio section of the module as required (see section “Configuring the Audio Processor”).
- Connect the computer to the module using the PGM800Win programming kit.



How to change the operating frequency

Description

There are two possible ways of changing the operating frequency:

Method 1	By using a computer running PGM800Win and • Changing the default channel in the existing setup or • Reprogramming the radio channel frequencies and then selecting a default channel NOTE: Please refer to the T830 service manual and the PGM800WIN programming manual for further instruction.
Method 2	By selecting a new channel using the DIP switch on the rear of the PCB Backplane or some other form of installed channel change switch i.e. BCD, Internal DIP switch.

After changing the operating frequency

Having changed the operating frequency of the T830 there are two different scenarios you will be faced with:

- You will change the frequency and the T830 will continue to operate correctly. In this case you have changed to a frequency within the switching band of the radio.
- You will change the frequency and the T830 will not operate or will not operate correctly. In this case you have changed to a frequency outside of the switching band.

Note: The radio must now be re-tuned (see next section “How to re-tune the T835” & “How to re-tune the T836/837”).

What is the switching band

Because of the high RF performance of the T800 series there is a limit to the amount of frequencies that the radio can switch to before re-tuning must occur. The limit is referred to as the switching bandwidth.

- The T830 Rx can switch up to 3MHz.
- The T830 Tx can switch up to 8MHz.

So if the T830 is optimally tuned to a centre frequency (which is often the case when sent from the factory) then the Rx or Tx will be able to switch half the switching band either side of that frequency.

Table Of Contents

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B	T835 Receiver Preliminary PCB Information
C	T836 Transmitter Preliminary PCB Information
D	T837 Exciter Preliminary PCB Information
E	T838 Power Amplifier Preliminary PCB Information
F	T839 Power Amplifier Preliminary PCB Information
G	T830 VCO Preliminary PCB Information
H	T800-22-0000 Rack Frame

Using The Parts Lists

In this manual there are separate parts lists for each product type. The table below shows which lists to use for each product type.

To refer to the parts list for a . . .	use the following sections . . .	
	T835/T836/T837	T838/T839
T83X-10	D83X-10-001 XE83X-10-001	D83X-10-0300 XE83X-10-0300
T83X-13	D83X-13-001 XE83X-13-001	
T83X-15	D83X-15-001 XE83X-15-001	
T83X-20	D83X-20-001 XE83X-20-001	D83X-20-0300 XE83X-20-0300
T83X-23	D83X-23-001 XE83X-23-001	
T83X-25	D83X-25-001 XE83X-25-001	
T83X-1X VCO	XE83XV10	
T83X-2X VCO	XE83XV20	



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Fax: 49 911 96 746-79

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