Technical Note TN-1027

Tait Orca Scanning & Voting Operation and Performance

27 May 2005

Applicability

This Technical Note applies to all Tait Orca 5000 series conventional radios. It discusses the general principles of how the Tait Orca 5000 series operating with Firmware Version 2.15 or above, scans and votes. It is not a definitive statement of all the options included in the Tait Orca (5000 series) scanning and voting algorithms.

This Technical Note supercedes TN-914 which details scanning and voting performance of Tait Orca 5000 Firmware Version 2.12.

Note: This is a <u>Tait Only</u> technical note and should not be distributed to Dealers

1. Introduction

Background

General Use for Scanning

This allows the user to monitor a number of (usually unrelated) channels for traffic of interest.

General Use for Priority Scanning

This allows the user to monitor a number of (usually unrelated) channels for traffic of interest, but also continuously monitor a "priority" channel, regardless of activity on the other channels.

General Use for Voting

This allows wide area communication with the radio unit selecting the "best" channel for communication.

To operate as a mobile voting network it is important that all base stations in the network transmit the same information at approximately the same time. In addition, for the vote to be effective it is important that all the base stations transmitters are at full power and stable. The faster the network design is able to accomplish this, the faster the vote in the radio unit can be initiated.

Operation – Scanning

Receiving (Scanning)

1. Member channels of the scan group are sampled sequentially and continuously.

2. If the conditions below are both satisfied the radio will capture that particular channel.
   - The radio detects activity on the channel.
   - The sub-audible signaling (if any) detected on the channel meets that programmed into the radio for the channel.

3. When a channel is captured, scanning is suspended causing the radio to lock onto that channel.

4. The 'Group Hold Time' actives when the channel capture conditions become invalid, after a channel has been captured. (eg: There is no activity detected on the channel).
   The 'Group Hold Time' resets if:
   - Valid activity is received
   - The radio is PTT'd
   - The radio is alerting an incoming call.

5. The radio will resume scanning when the 'Group Hold Time', which is programmable from 0 to 25 seconds in steps of 100ms, expires.

Note: If 'Economy Mode' operation is enabled and a scan group is selected, then 'Economy Mode' operation is deactivated.

Transmissions

- If a channel is captured and the PTT is pressed, then the radio will attempt to transmit on the captured channel.
- If the radio is scanning and the PTT is pressed, scanning is suspended and the 'home' channel selected. The 'home' channel is the first channel defined in the group membership list at time of programming.

In the above cases any programmed TX Inhibit conditions apply when the PTT is pressed.

Timing Information – Scanning

Below is a diagram that demonstrates the scanning operation on a Tait Orca 5020 using firmware V2.15 scanning 6 channels, spaced 10MHz apart.

Note that this format will be used throughout this document to demonstrate radio operation and performance.

- On the RF Signal trace, the transition from high to low indicates when the RF signal is presented to the radio antenna.
- On the VCO loop voltage trace, each incremental step represents the VCO having switched to a new frequency.
- On the Squelch Detect trace, the transition from low to high indicates that the squelch circuitry has detected activity on the current channel.
- On the Audio PA trace, the transition from high to low indicates the audio power amplifier is enabled and audio is heard from the speaker.
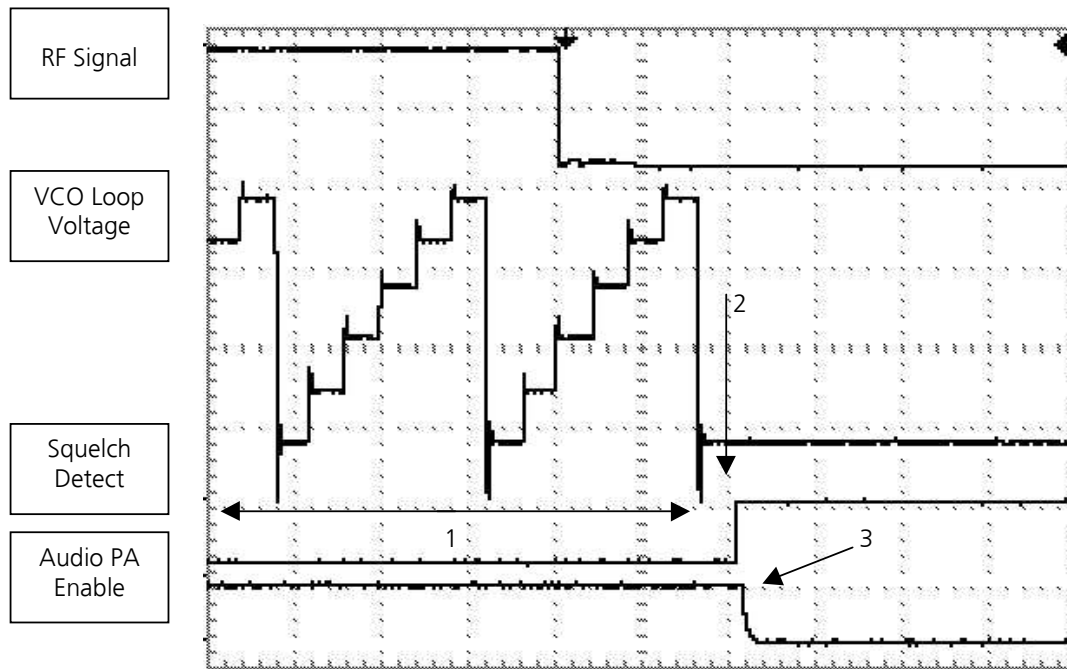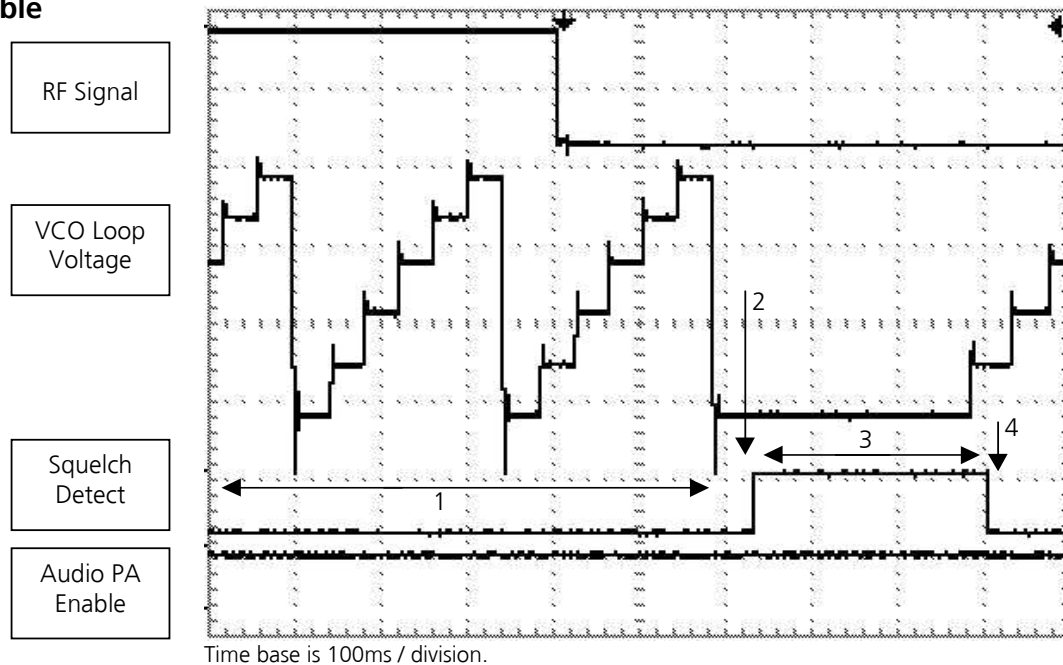

Time base is 100ms / division.

1. The radio begins scanning for channel activity. Approximate time per channel step is 40ms. This 40ms is made up of:
   - Approximately 30ms to allow the VCO to lock onto frequency.
   - Approximately 10ms to sample the channel for activity.

2. Activity is detected on channel – through the Squelch Detect line going high. This takes place approximately 40ms after stepping to this frequency and is made up of:
   - Approximately 30ms to allow the VCO to lock onto frequency.
   - Approximately 10ms period to detect activity.

3. Approximately 25ms later the audio circuitry completes power up, and the Audio PA line is enabled resulting in audio being heard from the speaker.

4. Not shown, once the RF signal is removed, the channel is held until the 'Group Hold Time' expires and the radio resumes scanning.

In this situation, scanning 6 channels the worst-case scenario will be where the RF signal is applied directly after the channel is scanned. In this case there will be approximately 270ms between application of the RF signal until audio is heard from the speaker.

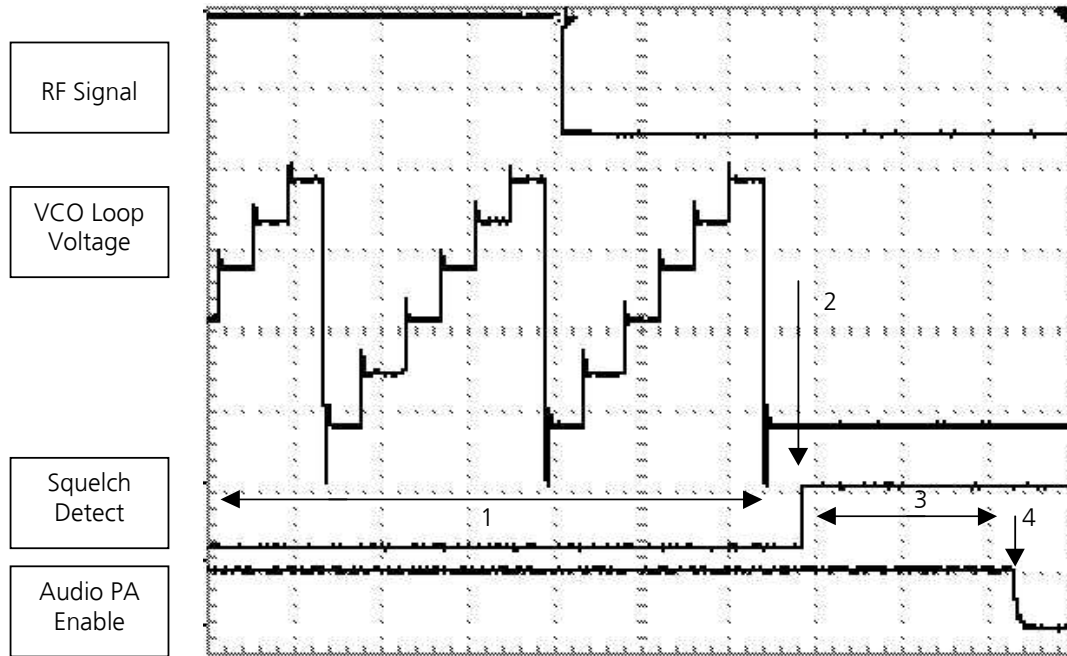**Timing Information – Scanning with invalid Sub-audible**

Below is a diagram that demonstrates the scanning operation with invalid sub-audible signaling on a Tait Orca 5020 using firmware V2.15 scanning 6 channels, spaced 10MHz apart.

| RF Signal |
| VCO Loop Voltage |
| Squelch Detect |
| Audio PA Enable |

Time base is 100ms / division.

1. The radio begins scanning for channel activity. Approximate time per channel step is 40ms. This 40ms is made up of:
   - Approximately 30ms to allow the VCO to lock onto frequency
   - Approximately 10ms to sample the channel for activity.

2. Activity is detected on channel – through the Squelch Detect line going high. This takes place approximately 40ms after stepping to this frequency and is made up of:
   - Approximately 30ms to allow the VCO to lock onto frequency.
   - Approximately 10ms period to detect activity.

3. The radio spends 270ms validating the CTCSS frequency. This sub-audible validation takes a maximum of 270ms and is dependent upon the sub-audible frequency programmed.

4. The sub-audible is not validated, thus the Audio PA is never enabled and the radio continues scanning, and repeats steps 1 to 3 above.

Timing Information – Scanning with valid Sub-audible

Below is a diagram that demonstrates the scanning operation with valid sub-audible signaling on a Tait Orca 5020 using firmware V2.15 scanning 6 channels, spaced 10MHz apart.

Time base is 100ms / division.

1. The radio begins scanning for channel activity. Approximate time per channel step is 40ms. This 40ms is made up of:
    - Approximately 30ms to allow the VCO to lock onto frequency
    - Approximately 10ms to sample the channel for activity.

2. Activity is detected on channel – through the Squelch Detect line going high. This takes place approximately 40ms after stepping to this frequency and is made up of:
    - Approximately 30ms to allow the VCO to lock onto frequency.
    - Approximately 10ms period to detect activity.

3. The radio spends 260ms validating the CTCSS frequency. This sub-audible validation takes a maximum of 270ms and is dependent upon the sub-audible frequency programmed. The sub-audible is validated as correct.

4. The Audio PA line is enabled, and audio is heard from the speaker.

5. Not shown, once the RF signal is removed, the channel is held until the 'Group Hold Time' expires and the radio resumes scanning.

In this situation, scanning 6 channels the worst-case scenario will be where the RF signal is applied directly after the channel is scanned. In this case there will be approximately 530ms between application of the RF signal to audio being heard from the speaker.

Operation – Priority Scanning

Receiving (Priority Scanning)

1. Member channels of the scan group are sampled sequentially and continuously.

2. If the conditions below are both satisfied the radio will capture that particular channel.
   - The radio detects activity on the channel.
   - The sub-audible signaling (if any) detected on the channel meets that programmed into the radio for the channel.

3. The programming software offers two 'Priority Sample Timers'. These are:
   - 'Non-Captured Sample Timer' – which dictates the time between samples of the priority channel when no other channel is currently captured. Programmable from 500 to 5000ms, in steps of 100ms, or set to 0 to disable extra sampling of priority channels.

   - 'Captured Sample Timer' – which dictates the time between samples of the priority channel when a non-priority channel has been captured. Programmable from 500 to 5000ms, in steps of 100ms, or set to 0 to disable extra sampling of priority channels.

4. If the captured channel is the priority channel then no priority sampling is performed.

5. If no channel is captured or the captured channel IS NOT the priority channel, then the priority channel will be sampled according to the following:
   - If no channel is captured then a priority sample occurs every time the 'Non-Captured Sample Timer' expires. Note: The priority sample occurs after the current channel sample has completed.

   - If a channel is captured that is not the priority channel, then a priority sample occurs as soon as the 'Captured Sample Timer' expires. The radios mute is closed as the sample of the priority channel is taken.

6. If the priority channel has no activity and is not captured then the radio will either:
   - Return to the place in the channel list where it currently was and continue sampling; or
   - Return to the previously captured channel, where the radios mute is reopened as soon as possible.

7. The 'Group Hold Time' actives when the channel capture conditions become invalid, after a channel has been captured. (eg: There is no activity detected on the channel).
   The 'Group Hold Time' resets if:
   - Valid activity is received
   - The radio is PTT'd
   - The radio is alerting an incoming call.

8. The radio will resume scanning when the 'Group Hold Time', which is programmable from 0 to 25 seconds in steps of 100ms, expires.

Note: If 'Economy Mode' operation is enabled and a scan group is selected, then 'Economy Mode' operation is deactivated.

Transmissions

- If a channel is captured and the PTT is pressed, then the radio will attempt to transmit on the captured channel.
- If the radio is scanning and the PTT is pressed, scanning is suspended and the 'home' channel selected. The 'home' channel is the first channel in the group membership list at time of programming.

In the above cases any programmed TX Inhibit conditions apply when the PTT is pressed.

Timing Information – Priority Scanning

Below is a diagram that demonstrates the priority scanning operation on a Tait Orca 5020 using firmware v2.15 scanning 6 channels, spaced 10MHz apart. **NB The 'Non-Captured Sample Timer' was programmed to 500ms. The 'Captured Sample Timer' was set to 500ms.**
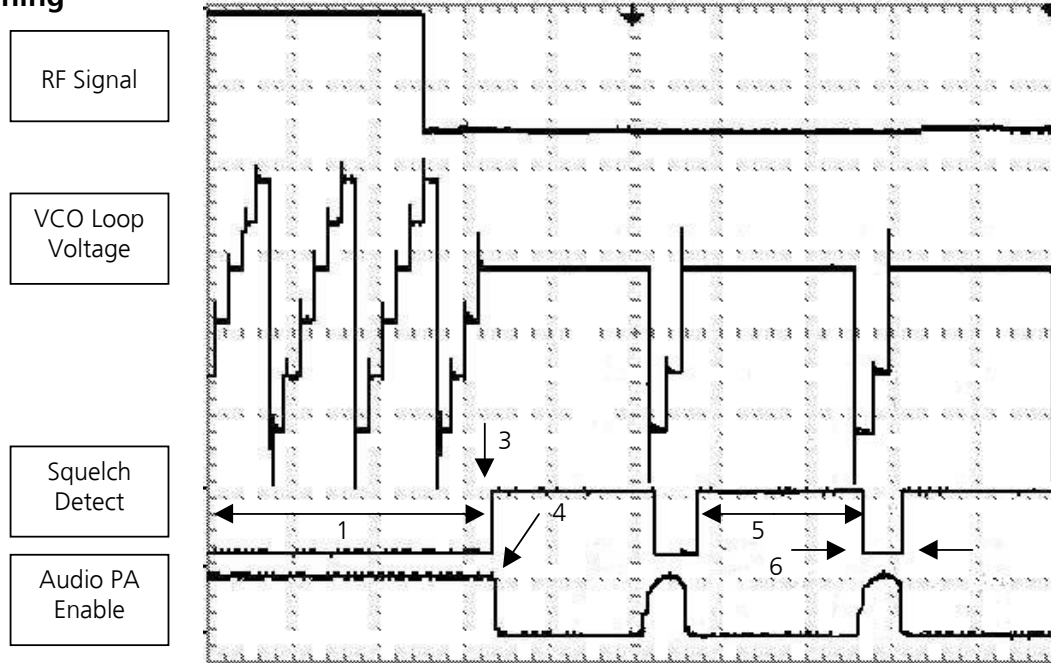
Refer to "Timing Information – Scanning" for a description of the diagram waveforms.
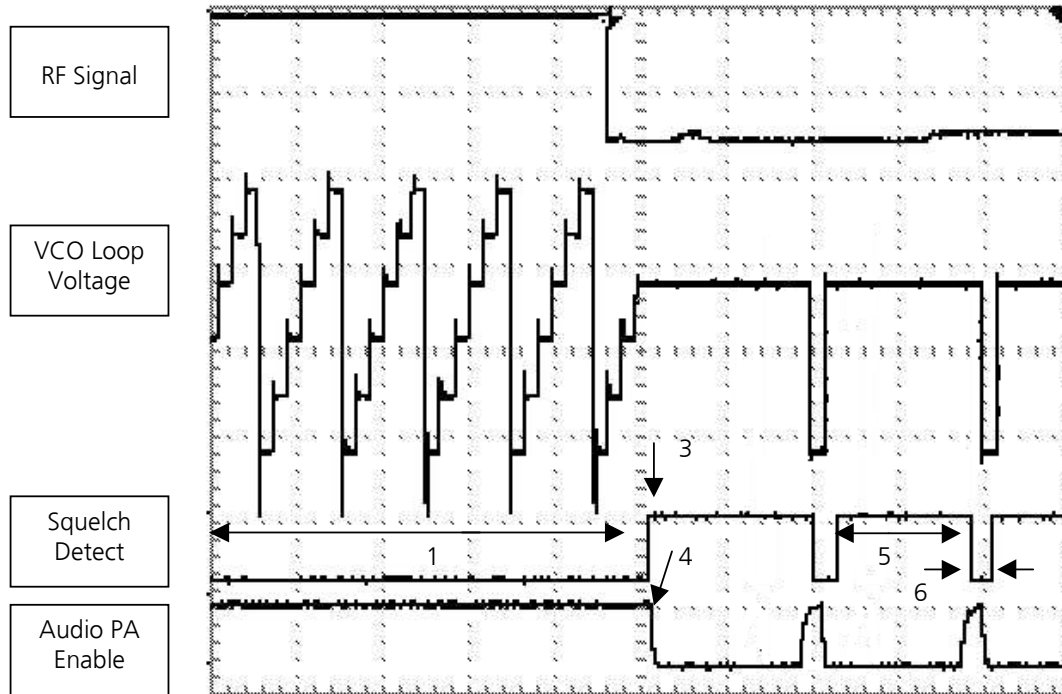
RF Signal

VCO Loop Voltage

Squelch Detect

Audio PA Enable

Time base is 250ms / division.

1. The radio begins scanning for channel activity. Approximate time per channel step is 40ms. This 40ms is made up of:
   - Approximately 30ms to allow the VCO to lock onto frequency
   - Approximately 10ms to sample the channel for activity.

2. Every 500ms the 'Non-Captured Sample Timer' expires and the priority channel is sampled for activity.
   (Sample time for activity detection on priority channel = 40ms)
   Note that this is for a scan group of channels where total scan time for all channels exceeds the Non Captured Sample Timer value.
   This is not displayed in this example as the total scan time is shorter than the 500ms Non Captured Sample Timer value.

3. Activity is detected on channel – through the Squelch Detect line going high. This takes place approximately 40ms after stepping to this frequency and is made up of:
   - Approximately 30ms to allow the VCO to lock onto frequency.
   - Approximately 10ms period to detect activity.

4. Approximately 25ms after the squelch detect line goes high, the Audio PA line is enabled, and audio is heard from the speaker.

5. As the captured channel is not the priority channel, the captured sample timer starts and when this timer expires the radio samples the priority channel. The Audio PA line is disabled as the sample is taken.

6. Sampling the priority channel takes approximately 70ms and as no activity is detected on the priority channel the radio returns to the previously captured channel with the Audio PA enabled again.

7. Not shown, once the RF signal is removed, the channel is held until the 'Group Hold Time' expires and the radio resumes scanning.

Timing Information – Dual Priority Scanning

Below is a diagram that demonstrates the dual priority scanning operation on a Tait Orca 5020 using firmware V2.15 scanning 6 channels, spaced 10MHz apart. **NB The 'Non-Captured Sample Timer' was programmed to 500ms. The 'Captured Sample Timer' was set to 500ms.**

RF Signal

VCO Loop Voltage

Squelch Detect

Audio PA Enable

Time base is 250ms / division.

1. The radio begins scanning for channel activity. Approximate time per channel step is 40ms. This 40ms is made up of:
    *   Approximately 30ms to allow the VCO to lock onto frequency
    *   Approximately 10ms to sample the channel for activity.

2. Every 500ms the 'Non-Captured Sample Timer' expires and the priority channels are sampled for activity.
    (Sample time for activity detection on each priority channel = 40ms)
    Note that this is for a scan group of channels where total scan time for all channels exceeds the Non Captured Sample Timer value.
    This is not displayed in this example as the total scan time is shorter than the 500ms Non Captured Sample Timer value.

3) Activity is detected on channel – through the Squelch Detect line going high. This takes place approximately 40ms after stepping to this frequency and is made up of:
    *   Approximately 30ms to allow the VCO to lock onto frequency.
    *   Approximately 10ms period to detect activity.

4) Approximately 25ms after the squelch detect line goes high, the Audio PA line is enabled, and audio is heard from the speaker.

5) As the captured channel is not one of the priority channels, the captured sample timer starts and when this timer expires, the radio samples the priority channels. The Audio PA line is disabled as the sample is taken.

6) Sampling the priority channels takes approximately 40ms per channel and as no activity is detected on the priority channels the radio returns to the previously captured channel with the Audio PA enabled again.

7) Not shown, once the RF signal is removed, the channel is held until the 'Group Hold Time' expires and the radio resumes scanning.

Operation – Voting

Receiving (Voting)

1. Member channels of the scan group are sampled sequentially and continuously.

2. Upon detection of activity on the channel, the radio commences the voting sequence.

3. The voting procedure is as follows:
   - If a 'Lead In Delay' is programmed, then the radio takes no action for the lead in interval. The 'Lead In Delay' is programmable from 0 to 2550ms, in steps of 10ms.
   - All member channels (commencing with the current channel) are then selected sequentially and a single signal strength (RSSI) measurement taken.
   - The channel with the highest measured signal strength (RSSI) from all samples taken is selected and recorded as the home channel.
   - The channel capture criterion is then applied to the home channel. (ie: Confirmation of valid activity on the channel).

4. If the voting group is defined as 'Double Voting' then the above step is repeated.

5. The 'Group Hold Time' actives when the channel capture conditions become invalid, after a channel has been captured. (eg: There is no activity detected on the channel).
   The 'Group Hold Time' resets if:
   - Valid activity is received
   - The radio is PTT'd
   - The radio is alerting an incoming call.

6. The radio will resume scanning when the 'Group Hold Time', which is programmable from 0 to 25 seconds in steps of 100ms, expires.
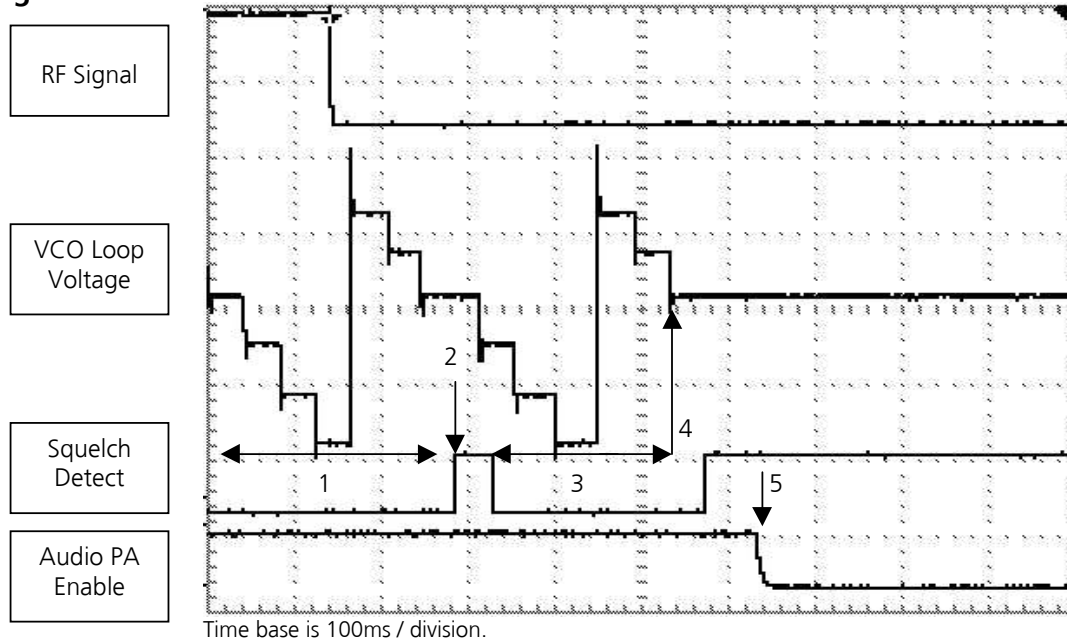
Note: If 'Economy Mode' operation is enabled and a voting group is selected, then 'Economy Mode' operation is deactivated.

Transmissions

- If a channel is captured and the PTT is pressed, then the radio will attempt to transmit on the captured channel.
- If the radio is voting and the PTT is pressed, scanning is suspended and the home channel selected. The 'home' channel is the first channel in the group membership list at time of programming, or if a vote has occurred then the channel with greatest RSSI is the home channel.

In the above cases any programmed TX Inhibit conditions apply when the PTT is pressed.
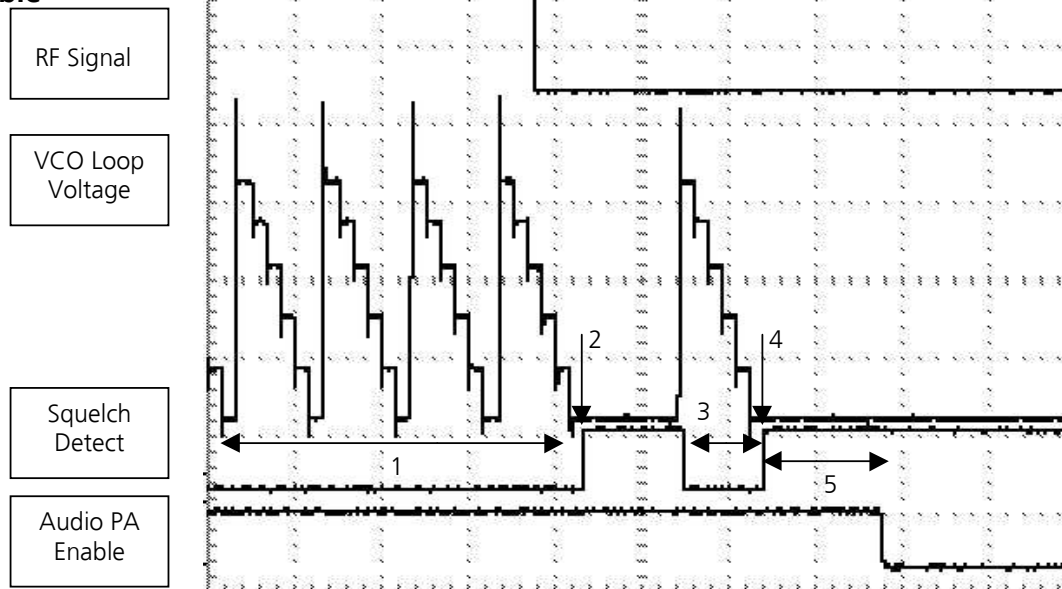
Timing Information – Voting

Below is a diagram that demonstrates the voting operation on a Tait Orca 5020 using firmware V2.15 scanning 6 channels, spaced 10MHz apart.

RF Signal

VCO Loop Voltage

Squelch Detect

Audio PA Enable

Time base is 100ms / division.

1. The radio begins scanning for channel activity. Approximate time per channel step is 40ms. This 40ms is made up of:
   - Approximately 30ms to allow the VCO to lock onto frequency
   - Approximately 10ms to sample the channel for activity.

2. Activity is detected on channel – through the Squelch Detect line going high. This takes place approximately 40ms after stepping to this frequency and is made up of:
   - Approximately 30ms to allow the VCO to lock onto frequency.
   - Approximately 10ms period to detect activity and perform RSSI check.
   - Radio monitors activity.
   - The radio now waits for the 'Voting Lead in Delay', which is programmed in this instance to 30ms.

3. Then a signal strength measurement (RSSI) is performed on all channels. This takes approximately 40ms per channel and comprises of:
   - Approximately 30ms to allow the VCO to lock onto frequency
   - Approximately 10ms to sample the channels signal strength (RSSI).

4. The vote completes and the channel with highest signal strength measurement (RSSI) is captured and marked as the home channel.

5. Approximately 70ms after the switching to the channel with highest signal strength measurement (RSSI) the Audio PA line are enabled and audio is heard from the speaker.

6. Not shown, once the RF signal is removed, the channel is held until the 'Group Hold Time' expires and the radio resumes voting scan.

In this situation, a voting scan group with 6 channels the worst-case scenario will be where the RF signal is applied directly after the channel is scanned. In this case there will be approximately 400ms between application of the RF signal to audio being heard from the speaker.

Timing Information – Voting with Sub-audible

| RF Signal |
| VCO Loop Voltage |
| Squelch Detect |
| Audio PA Enable |

Below is a diagram that demonstrates the voting with sub-audible operation on a Tait Orca 5020 using firmware V2.15 scanning 6 channels, spaced 10MHz apart.

Time base is 250ms / division.

1. The radio begins scanning for channel activity. Approximate time per channel step is 40ms. This 40ms is made up of:
   - Approximately 30ms to allow the VCO to lock onto frequency
   - Approximately 10ms to sample the channel for activity.

2. Activity is detected on channel. On this channel there is an approximate 300ms sample. This represents:
   - Approximately 30ms to allow the VCO to lock onto frequency
   - Approximately 10ms to detect activity.
   - Approximately 230ms to validate the sub-audible frequency.
   - The 'Voting Lead in Delay', which is programmed in this instance to 30ms.

3. Then a signal strength measurement (RSSI) along with a sub-audible validation is performed on all channels. This takes approximately 40ms per channel and comprises of:
   - Approximately 30ms to allow the VCO to lock onto frequency
   - Approximately 10ms, to sample the channel waiting for valid activity. If valid activity is detected a validation of the channels sub-audible will occur. Sub-audible validation time varies with the sub-audible frequency, with a maximum of 270ms to validate the sub-audible signal.

4. The vote completes and the channel with highest signal strength measurement (RSSI) AND valid sub-audible signaling is captured and marked as the home channel.

5. The sub-audible is again validated (This takes approximately 230ms). Approximately 70ms later the Audio PA line is enabled, and audio is heard from the speaker.

6. Not shown, once the RF signal is removed, the channel is held until the 'Group Hold Time' expires and the radio resumes voting scan.

In this situation, a voting with signaling scan group with 6 channels the worst-case scenario will be where the RF signal is applied directly after the channel is scanned. In this case there will be approximately 1150ms between application of the RF signal to audio being heard from the speaker.

Double Voting

Double voting functions in exactly the same way as standard voting except that the voting sequence is conducted twice. The channel with the highest measured signal strength measurement (RSSI) on the second vote sequence will be captured and marked as the home channel.

Double Voting without Sub – Audible Signalling

In this situation of double voting without signalling with 6 channels, the worst case scenario will be where the RF signal is applied directly after the channel is scanned.
There would be approximately 920ms between application of the RF signal to audio being heard from the speaker.

Double Voting with Sub – Audible Signalling

In this situation of double voting with signalling with 6 channels, the worst case scenario will be where the RF signal is applied directly after the channel is scanned. There would be approximately 1650ms between application of the RF signal to audio being heard from the speaker.

Timing Information - Fast Vote

The Fast Vote option allows the radio to capture a channel without completing the voting process if the received signal strength is equal to or greater than the programmed threshold.

A value from -115 to -60 dBm, or 0 to disable Fast Vote must be entered in the Fast Vote field on the Scan group members table.

The PGM application used in this instance is version 4.02.00.

Below is a diagram that demonstrates the fast voting operation on a Tait Orca 5020 using firmware V2.15 scanning 6 channels, spaced 10MHz apart.

Note in this example the programmed signal level for fast vote option is –95dBm and the receive signal level is –90dBm.
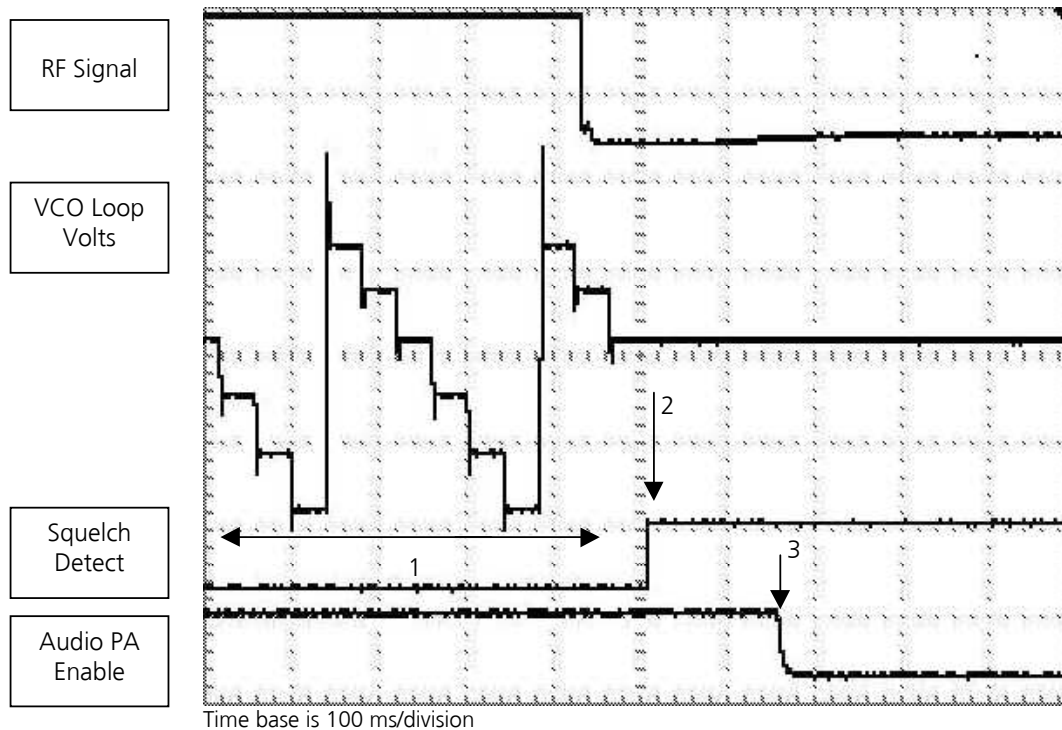
RF Signal

VCO Loop Volts

Squelch Detect

Audio PA Enable

Time base is 100 ms/division

1) The radio begins scanning for channel activity. Approximate time per channel step is 40ms. This 40ms is made up of:
   - Approximately 30ms to allow the VCO to lock onto frequency
   - Approximately 10ms to sample the channel for activity.

2) Activity is detected on channel. This is shown by the squelch detect line going high. On this channel there is an approximate 170ms sample. This represents:
   - Approximately 30ms to allow the VCO to lock onto frequency
   - Approximately 10ms to detect activity.
   - Approximately 100ms to monitor activity and validate RSSI level.
   - Approximately 30ms for audio P.A to fully activate.

3) Audio is enabled immediately as the incoming signal level exceeds the programmed level hence voting RSSI validation is cancelled and radio goes straight to channel.

4) Not shown, once the RF signal is removed, the channel is held until the 'Group Hold Time' expires and the radio resumes voting scan.

Fast Vote Timing Scenarios

In this situation, using the fast vote option with 6 channels, the worst-case scenario will be where the RF signal is applied directly after the channel is scanned. In this case there will be approximately 420ms between application of the RF signal to audio being heard from the speaker.

In the situation where valid sub-audible tone is being used, using fast vote with 6 channels, the worst-case scenario will be where the RF signal is applied directly after the channel is scanned. In this case there will be approximately 930ms between application of the RF signal to audio being heard from the speaker.
This would be dependent on the sub-audible tone used which extends the validation time of the activity detect and squelch detect process.

Compliance Issues   None

CSO Instruction   Please inform all Technical Staff of this information. **This information should not be disclosed to Dealers.**

3.   Issuing Authority

Name and Position of Issuing Officer

Chris Thomson
Technical Support

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