Configuring TaitNet Networks for Sharing Channel Resources

16 May 2003

1 Introduction

1.1 Scope

In situations where insufficient channel resource exists for each site to have unique use of all its channels across its coverage area, a means of sharing the available channel resource must be used. With TaitNet networks, there are two distinctly different methods for achieving this. The method that should be selected depends upon the ability of the network to control access to the shared resource.

- If the channel resource is to be shared between sites that are part of the same network, then the network itself can arbitrate access to the shared resource, and the best solution is to use the "pooled channel" feature.
- If the channel resource is to be shared between sites that are not part of the same network, then the network is unable to arbitrate access to the shared resource, and the only solution is to use the "transmit inhibit on busy channel" (or "shared channels") feature.

While it is possible to use a combination of pooled and shared channels in a single network, individual channels that are both shared and pooled are subject to a number of restrictions in their use. Therefore, when designing the channel allocation for a network, channels that need to be both shared and pooled should be avoided.

1.2 Abbreviations

CCM	Channel Control Module
CMM	Channel Management Module (the replacement for the CCM)
MAX	The CMM's main processor
NMT	Network Management Terminal
SCU	Site Control Unit
SMM	Site Management Module

Note: Where the term CMM is used, this is normally taken to refer to the CCM as well.

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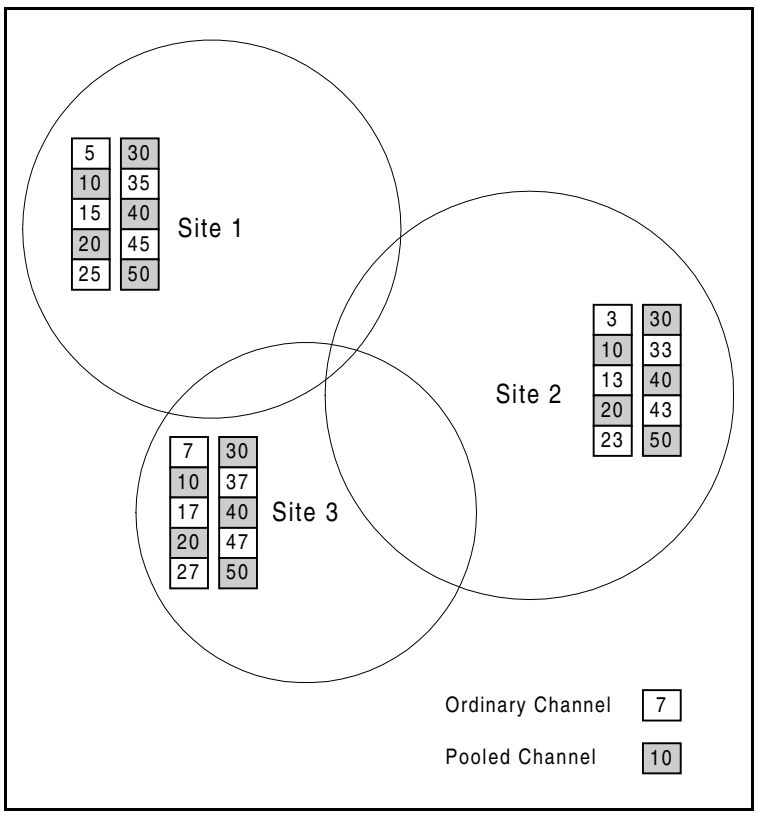
2 Pooled Channels Feature

If your network provider only has permission to operate with a limited number of channel frequencies, you can pool channels. This enables you to reduce the total number of frequency pairs that the TaitNet network needs. Also, if you discover unexpected frequency interference between sites, you can easily solve the problem by pooling any common channels.

2.1 Feature Overview

Pooled channels are frequency pairs that are shared among channels at different but overlapping sites. The node ensures that a pooled channel is inactive if another channel is using the frequency pair.

In the example shown in the diagram below, three sites with overlapping coverage each have 10 channels; five unique and five pooled. Pooling channels reduces the total number of frequency pairs used from 30 to 20.



2.2 How the Pooled Channel Feature Works

Normally, sites with overlapping coverage must use different channel frequencies, because signals on the same frequency would interfere with each other. Pooled channels allow overlapping sites to use the same frequency pair. Any traffic channel can be pooled. The node prevents the sites from using the same frequency pair at the same time.

The pooled channels feature can be set up on the T1541 NMT in the Site Status window. When you set up pooled channels, the node provides the sites with information about which channels are pooled. When a site receives a call request and all its non-pooled channels are busy, it asks the node to specify a free pooled channel. The node checks its information about which pooled channels are in use, and supplies the site with a channel number, which the site uses to set up the call.

Refer to "LED Display Status (Traffic Channels Only)" on page 6 for information on how a pooled channel status is displayed on CCMs and CMMs.

2.3 Requirements

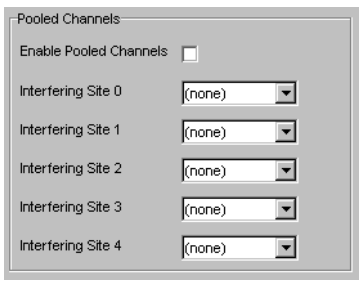
The pooled channel feature is only available if the T1541 NMT has been configured to allow pooled channels.

In the File > Configuration > Advanced > Features tab, the Feature.Site.ChannelPooling value should be set to "True". Refer to the *NMT Operations Manual* (Section 5.4 "Features" in Part D: Configuration Menu) for more information.

2.4 Setting Up Pooled Channels

To pool channels when the network is first installed, follow these steps:

1. Decide which channel frequencies and which channel equipment will be pooled.
2. Configure that equipment to use pooled channel frequencies.
3. Use the NMT to specify which sites with pooled channel frequencies have overlapping coverage. For each of these sites follow these steps:
    a) Select *Site* > Site Status, then select the Configuration tab. This contains a Pooled Channels area.



    b) Select the Enable Pooled Channels check box.
    c) Using the drop-down lists, select up to five other sites whose coverage overlaps the selected site. (An interfering site is a site that can cause RF interference with the selected site. Its coverage must overlap with the selected site's coverage, and it must have at least one frequency pair in common.)
    d) Press Apply.

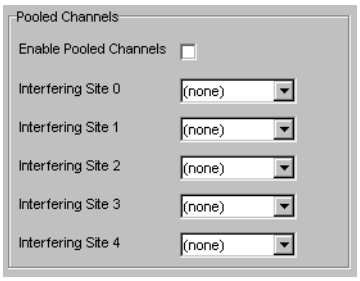
The node now automatically pools any channels common to the selected site and one or more of the interfering sites.

2.5 Pooling Interfering Channels

If, once the network is up and running, you discover that two or more channels with the same RF frequency pair are interfering with each other, you can pool them to eliminate this interference.

For each of the sites with interfering channels, follow these steps:

1. Select *Site* > Site Status, then select the Configuration tab. This contains a Pooled Channels area.



2. Select the Enable Pooled Channels check box.
3. Select the other interfering sites from the drop-down lists, then press Apply.

3 Transmit Inhibit on Busy Channel Feature

3.1 Feature Overview

The purpose of the Transmit Inhibit on Busy Channel features are to permit one or more channels at a site to occupy frequencies that are used by other systems. In a "transmit inhibit on busy channel" (also called a "shared channel") site, the control channel, before allocating a call to a traffic channel, must ascertain that the traffic channel is not currently being used by another system. In addition, when the control channel reserves a traffic channel, the traffic channel will activate its transmitter to prevent other systems from using it.

The Transmit Inhibit on Busy Channel features comply with Level 1 monitoring as specified in the FCC's Public Notice "*Private Land Mobile Radio - Monitoring Levels for Non-exempt Trunked Systems on Channels Between 150 - 512 MHz*" (DA 01-2852), published December 7, 2001.

3.2 How the Transmit Inhibit on Busy Channel Features Work

Detection of Interference

A traffic channel using the Transmit Inhibit on Busy Channel software detects whether it is in a jammed (or interference) state, even when the Transmit Inhibit on Busy Channel features are not turned on. Each channel informs the control channel of its jammed status. The site then reports the jammed status of each channel to the node.

A channel is considered to be in a jammed state if the receiver gate is closed for longer than the Receiver Activity Timeout.

Allocation of Calls to Traffic Channels

A traffic channel can be configured as either a transmit inhibit on busy channel or a dedicated channel. The traffic channel informs the control channel of its channel configuration status (transmit inhibit on busy channel or dedicated channel). If a traffic channel is a transmit inhibit on busy channel and it is in the jammed state then the control channel will not allocate a call to that channel.

Inhibiting Other Systems from Using a Reserved Channel

When the control channel is setting up a call, it looks for an empty traffic channel before it places the call. If it finds one it will "reserve" it and then set up the call. If there is no free traffic channel the call is queued until one becomes free.

When in the "reserved" state, a traffic channel configured as a transmit inhibit on busy channel activates its transmitter, thereby dissuading other users from attempting to use the channel at that time.

Transmit Inhibit on Busy Channel Procedure on Start-up or Reset

When a trunked radio system with the Transmit Inhibit on Busy Channel features starts up or is reset, the CMM is programmed to make the lowest numbered channel the control channel, on the following conditions:

a) that it is configured to be able to be a control channel, and;

b) that it is not in use by another system (ie that it is not in the jammed state)

If these conditions are not met, then the next lowest numbered channel is tested, until a suitable control channel can be found.

Using a Transmit Inhibit on Busy Channel for the Control Channel

It is preferable that the control channel is allocated to a dedicated channel, but if all available channels are shared, then channels can be configured to allow the control channel to rotate around a number of traffic channels in turn. The minimum control channel dwell time at each channel is a configurable parameter.

It is possible to configure one or more traffic channels to "opt out" of this rotation cycle, therefore ensuring that these channels remain as traffic channels at all times. The traffic channel informs the control channel of its control channel inhibit status, and this ensures it does not participate in the control channel selection process.

Control channel rotation will occur only when all channels at a site are in the "idle" state, ie, no calls are in progress or queued, and before a channel is selected as the new control channel, a check is performed to ensure it is not in the jammed state.

LED Display Status (Traffic Channels Only)

Where T1510 and T1511 CCMs have a front panel with an LED display, the yellow Sync LED will now display state information for a traffic channel (previously it only flashed when the CCM was operating as a control channel).

On the T1711 CMM the green Sync LED is the only LED on the CMM board, and it also displays state information for a traffic channel. (The T1711 CMM does not have any LEDs on its front panel.)

Any traffic channel, regardless of whether Inhibit If Jammed is enabled or not, will display interference with a slow flash of the Sync LED. It will also display this slow flash on startup or reset, as the channel assumes it is jammed until it establishes that it is not. Once the interference has ceased, if the channel is pooled the Sync LED will turn "on", if the channel is not pooled the Sync LED will turn "off". In addition, when a traffic channel is in the "reserved" state, the Sync LED will turn "on". (See Footnote 1.)

The following table lists the various functions of the Sync LED.

Behaviour	CMM status	Meaning
Fast flashing cycle (10 Hz)	Control channel	This is the control channel
Slow flashing cycle (0.5 Hz)	Traffic channel	This channel is in a jammed state
LED "on"	Traffic channel	This channel is either in a "reserved state"[1] or is a pooled channel not in a jammed state
LED "off"	Traffic channel	This channel is in either an "idle" or an "active" state[2] and is not pooled

1 The reserved state is used when a traffic channel is "on hold" waiting for an intersite or emergency call to setup.
2 Activity on the "Talk Through" or "Signalling" LEDs implies that this traffic channel is active in a call.

Footnote 1. On system startup, one or two minutes will elapse while the node establishes which channels are pooled, and then transmits this information to the sites. Therefore, do not expect a pooled channel indication to be displayed immediately after startup.

3.3 Requirements of Transmit Inhibit on Busy Channel Sites

Minimum Number of Channels per Site

A four channel site is recommended as a minimum, although a three channel site is acceptable in a low use environment.

It is recommended that sites using transmit inhibit on busy channels do not assign the CMM number 0 to any of its channels.

CMM Numbering at a Site with Dedicated and Transmit Inhibit on Busy Channels

At a mixed site, with dedicated channels and transmit inhibit on busy channels, the dedicated channels should be given CMM numbers that are lower than the CMM numbers given to the transmit inhibit on busy channels. This will ensure that the CMM will attempt to allocate the control channel to one of the dedicated channels before it has to try the transmit inhibit on busy channels. See "Transmit Inhibit on Busy Channel Procedure on Start-up or Reset" on page 5.

Transmit Inhibit on Busy Control Channel

It is recommended that the control channel is allocated to a dedicated channel where possible, especially if the site is a busy one. However, the Transmit Inhibit on Busy Channel features have been designed so that transmit inhibit on busy channels can be used as control channels with no significant change to the grade of service provided.

Pooled Channels with Transmit Inhibit on Busy Channel Features Enabled

If a pooled channel has transmit inhibit on busy channel mode parameters enabled, the control channel will not make a request to the node for allocation while it is in the jammed state. The control channel will not request the channel until the Receiver Inactivity Timeout period has elapsed after the channel has cleared down. This makes a pooled transmit inhibit on busy channel less efficient in resource use when the only interference is from other sites in the same network, and not from other systems.

If a pooled channel is configured to be a transmit inhibit on busy channel as well, the feature whereby a reserved transmit inhibit on busy channel activates its transmitter to prevent others from using the system will not work.

Management and Status

The Transmit Inhibit on Busy Channel feature can be set up and configured on the T1541 NMT. See "Configuring the T1541 NMT for Transmit Inhibit on Busy Channel Operations" on page 7.

TaitNet systems that do not have a T1541 NMT can only configure this feature by modifying the configuration parameters stored in the main processor memory of the CMM. See "Appendix A" on page 14.

3.4 Configuring the T1541 NMT for Transmit Inhibit on Busy Channel Operations

Note: This feature was added in version 2.1.5. Earlier versions of the T1541 node and NMT do not include this feature and should be upgraded.

The configuration parameters relevant to the Transmit Inhibit on Busy Channel feature consist of three control parameters and two system parameters.

The control parameters (control channel reassignment timeout, receiver inactivity timeout and receiver activity timeout) are part of the NMT control parameter blocks. The system parameters (control channel inhibit and inhibit if jammed) are configured as required for each channel at each site on the NMT.

The following table summarises the Transmit Inhibit on Busy Channel parameters, together with their locations and default values.

Location	Parameter Name	Default
Node > Control Blocks	Control Channel Reassignment Timeout	Disabled
Node > Control Blocks	Receiver Inactivity Timeout	5 seconds
Node > Control Blocks	Receiver Activity Timeout	0.8 second
Site > Channels	Control Channel Inhibit	off
Site > Channels	Inhibit If Jammed	off

Control Channel Reassignment Timeout

This is the frequency, in minutes, with which the control channel should move to a new channel. If a control channel cannot find a new channel to move to when the time has expired, it will continue to be the control channel, wait for a short period, then attempt the move again. It will continue to do this until it is successful.

Control channel transfer will occur only when the site is idle, that is with no calls in progress and no calls queued.

The default value is "Disabled" which means the control channel does not move.

Receiver Inactivity Timeout

Receiver inactivity timeout is the number of seconds that a channel listens on its receiver gate, without detecting interference, before deciding that this channel is not in an interference state.

Activity that persists for less than receiver activity timeout (see below) is not considered interference.

The default value is 5 (seconds).

Receiver Activity Timeout

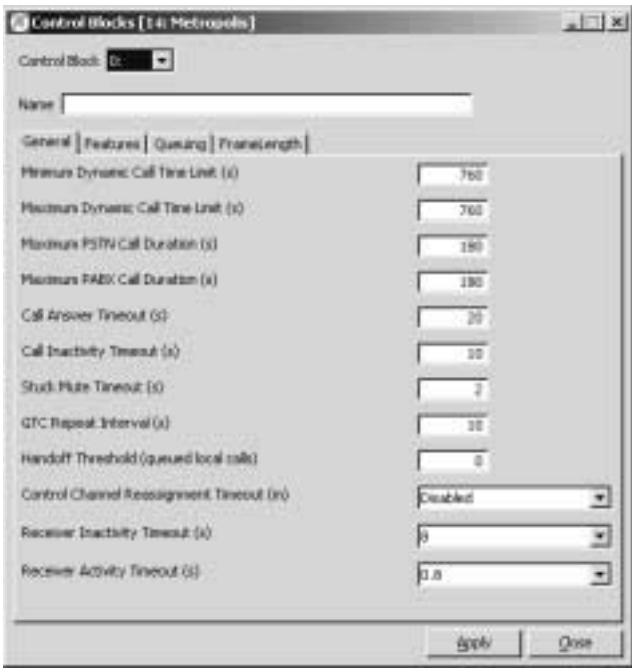
Receiver activity timeout is the length of time, in seconds, for which a channel will detect activity on its receiver gate before it registers that interference does exist on the channel.

The receiver activity timeout should be set to a value that ensures that ordinary noise and static are not confused with interference.

The default value is 0.8 (second).

Procedure for Setting the Transmit Inhibit on Busy Channel Control Parameters

1. Select *Node* > Control Blocks. The Control Blocks window appears.



2. Select from the Control Block drop-down list the number of a control block.
3. In the Name box, enter a suitable name for that control block. This name will appear in the Control Block drop-down list.
4. Under the General tab, configure the transmit inhibit on busy channel control parameters by selecting a value from the drop-down list for each parameter. Press Apply, to ensure that you do not lose your changes.
5. Press Close to close the window.

Note: When editing control blocks, please allow two minutes for the changes to be received and updated by the site

Control Channel Inhibit

If this parameter is turned on, this CMM cannot be a control channel. It will not attempt to be a control channel on either startup, reset or control channel failure, neither will it be asked to be a control channel when the control channel is rotated. This is a strong prohibition, and it should be used only where there is a valid reason to prohibit a CMM from taking over as the control channel under any circumstance.

Two examples of this parameter's use are detailed in Section 4. In both examples there is a specific reason why certain channels at the site must never be the control channel. With "Four Channel System, All Shared, One Intersite Channel" on page 12, the control channel must not shift to the intersite channel, as this would prohibit intersite calls. With "Six Channel System, All Shared, Radios can 'Hunt' for only Four Channels" on page 13, the control channel must not shift to a channel that is not in the radios' hunt list.

The default value is "off" which means the CMM can be a control channel.

Inhibit If Jammed

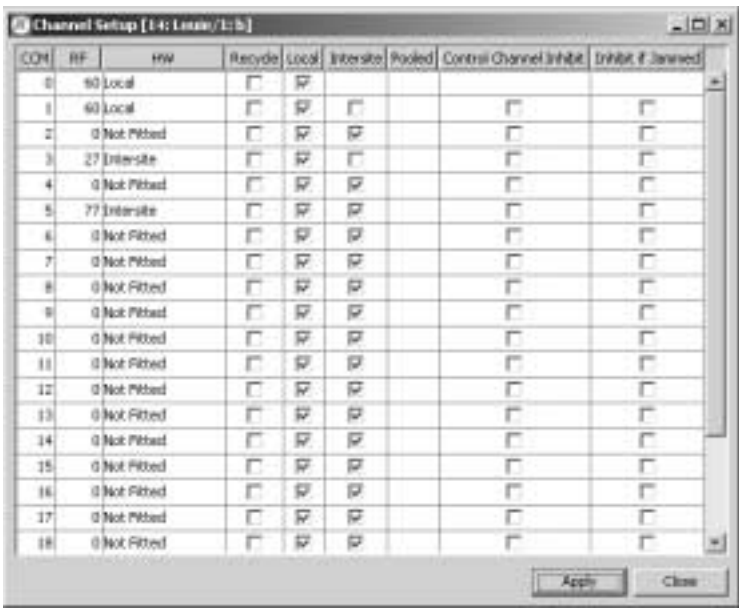
If this parameter is turned on, the control channel will not allocate a call to this channel when it is "in use by another system", nor will this channel attempt to be the control channel on either power-up/reset or on control channel failure until it has determined that it is not "in use by another system".

If this parameter is turned off, the control channel will allocate a call to this channel whether it is "in use by another system" or not, and the channel will not test that it is not "in use by another system" before assigning itself to the control channel on either power-up/reset or on control channel failure.

The default value is "off".

Procedure for Setting the Transmit Inhibit on Busy Channel System Parameters

1. Select *Site* > Channels. The Channel Setup window appears.



2. If you want to ensure that a channel never becomes a control channel, then select the Control Channel Inhibit check box to turn this parameter on.
3. If you want to ensure that calls will not be allocated to a channel if interference is detected, then select the Inhibit If Jammed check box to turn this parameter on.
4. Press Apply, to ensure that you do not lose your changes, then press Close to close the window.

4 Example System Configurations

Here are some examples that list the transmit inhibit on busy channel control parameter choices for sample systems.

Note: Where the value n/a is entered in the tables in these configurations, this value is not used by the software in this particular configuration.

If the Control Channel Inhibit parameter is set to on, then the value of the Control Channel Reassignment Timeout parameter is not relevant and is ignored by the CMM software.

If the Inhibit If Jammed parameter is set to off, then the values of the Receiver Inactivity Timeout and the Receiver Activity Timeout parameters are not relevant and are ignored by the CMM software.

4.1 Three Channel System, One Dedicated Channel Available

The dedicated channel is used for the control channel. It is given the lowest CMM number (1). The other channels are set up so that they can perform as the control channel in the event of failure of the dedicated channel. Should the dedicated channel fail, the other channels will rotate the control channel at intervals. When the dedicated channel comes back 'on line', and the control channel rotates to it in the course of reassignment, it will once again become a permanent control channel.

The dedicated channel is configured to disable "control channel reassignment time-out". This means that when this channel is the control channel it does not have to move to another channel. (At system startup or reset, it will always be the control channel because it has the lowest CMM number.) As this channel is a dedicated channel, it is configured with inhibit if jammed "off". The transmit inhibit on busy channel control parameters for this channel have the following configuration:

Parameter Name	Value
Control Channel Reassignment Timeout	Disabled
Receiver Inactivity Timeout	n/a
Receiver Activity Timeout	n/a
Control Channel Inhibit	off
Inhibit If Jammed	off

The other two channels are configured so that if they do become the control channel, they can only be control channel for 15 minutes. They are configured to be allowed to be the control channel (in case the dedicated channel fails). As these channels are not dedicated channels they are configured with inhibit if jammed "on". The transmit inhibit on busy channel control parameters for these channels have the following configuration:

Parameter Name	Value
Control Channel Reassignment Timeout	15 (minutes)
Receiver Inactivity Timeout	5 (seconds)
Receiver Activity Timeout	0.8 (second)
Control Channel Inhibit	off
Inhibit If Jammed	on

4.2 Four Channel System, All Shared, One Intersite Channel

All the channels are shared, therefore the control channel will need to rotate. As this system has but one intersite channel, if this channel takes turns at being the control channel, then for the period during which it is the control channel, no intersite calls will be possible.

The intersite channel is configured never to be a control channel, even in the case of channel failure. It is configured as an inhibit if jammed channel. The transmit inhibit on busy channel control parameters for this intersite channel have the following configuration:

Parameter Name	Value
Control Channel Reassignment Timeout	n/a
Receiver Inactivity Timeout	5 (seconds)
Receiver Activity Timeout	0.8 (second)
Control Channel Inhibit	on
Inhibit If Jammed	on

The other three channels are configured so that when they do become the control channel, they can only be control channel for 15 minutes. They are configured to be allowed to be the control channel, and they are also inhibit if jammed channels. The transmit inhibit on busy channel control parameters for these channels have the following configuration:

Parameter Name	Value
Control Channel Reassignment Timeout	15 (minutes)
Receiver Inactivity Timeout	5 (seconds)
Receiver Activity Timeout	0.8 (second)
Control Channel Inhibit	off
Inhibit If Jammed	on

4.3 Six Channel System, All Shared, Radios can 'Hunt' for only Four Channels

All the channels are shared, therefore the control channel will need to rotate. If all six channels take turns at being the control channel, there will be times when the radios will be unable to find the control channel, as four channels only are on each radio's hunt list.

The four channels in the radio hunt list are configured so that when they do become the control channel, they can only be control channel for 15 minutes. They are configured to be allowed to be the control channel, and they are also inhibit if jammed channels. The transmit inhibit on busy channel control parameters for these channels have the following configuration:

Parameter Name	Value
Control Channel Reassignment Timeout	15 (minutes)
Receiver Inactivity Timeout	5 (seconds)
Receiver Activity Timeout	0.8 (second)
Control Channel Inhibit	off
Inhibit If Jammed	on

The other two channels are configured never to be a control channel, even in the case of channel failure. They are configured as inhibit if jammed channels. The transmit inhibit on busy channel control parameters for these channels have the following configuration:

Parameter Name	Value
Control Channel Reassignment Timeout	n/a
Receiver Inactivity Timeout	5 (seconds)
Receiver Activity Timeout	0.8 (second)
Control Channel Inhibit	on
Inhibit If Jammed	on

4.4 Non-shared, four channel system with one pooled channel

Although this is a non-shared system, the control channel inhibit parameter can be enabled on the pooled channel to ensure that it never becomes the control channel. (When the control channel moves to a pooled channel, the channel is reserved for that site alone and other sites that might want to use it become unable to do so.)

The three non-pooled channels are set up as “normal” channels, with the following configuration:

Parameter Name	Value
Control Channel Reassignment Timeout	Disabled
Receiver Inactivity Timeout	n/a
Receiver Activity Timeout	n/a
Control Channel Inhibit	off
Inhibit If Jammed	off

The pooled channel has Control Channel Inhibit set to on, as in the following configuration:

Parameter Name	Value
Control Channel Reassignment Timeout	n/a
Receiver Inactivity Timeout	n/a
Receiver Activity Timeout	n/a
Control Channel Inhibit	on
Inhibit If Jammed	off

5 Appendix A

5.1 Configuring the CMM for Transmit Inhibit on Busy Channel Operations

If your TaitNet system has a T1772 Network Management Terminal, then the transmit inhibit on busy feature cannot be set up and configured using the NMT. The T1772 NMT has no support for either configuration or monitoring of this feature, so it has to be configured directly into the CMM software. This also applies to older TaitNet nodes and NMTs, for example, the T1530 and T1540.

The configuration parameters relevant to the Transmit Inhibit on Busy Channel feature are stored in the memory connected to the address bus of the main processor of the CMM. The software that is stored in this memory is normally referred to as the Q1510MAX software.

Refer to the "*T1711 CMM Operations Manual*" for information on any other parameters.

To use any of the "transmit inhibit on busy channel" features on these systems, you must set the required values directly into the FLASH of the CMMs as follows:

Name	Units[1]	Address[2]	Default[3]	Useful Range[4]	Hex[5]
Control channel reassignment timeout	minutes	$80FD	0 (ie Disabled)	0 or 15 to 60	00 or 0F to 3C
Receiver inactivity timeout	seconds	$8101	5	3 to 10	03 to 0A
Receiver activity timeout	0.2 second	$8102	4	2 to 6	02 to 06
Control channel inhibit		$8408	2*	0 "off" or 1 "on"	00 or 01
Disable jammed channel		$8409	2*	0 "off" or 1 "on"	00 or 01
NMT disable parameters ($FF prevents non-shared channel savvy NMTs from overwriting shared channel parameters.)		$811E	0*	255	FF
		$8126	0*	255	FF
		$8128	0*	255	FF

1. Units: the measurement units for the parameter

2. Address: The address of the parameter in the FLASH
3. Default: The value in the FLASH if not modified
4. Useful Range: Recommended guidelines for minimum and maximum settings
5. Hex: The "Useful Range" values converted into Hexadecimal

Warning: Values marked with an asterisk (*) MUST be altered to the value(s) in the "Useful Range" column for non-T1541 systems. The "Default" values will not work in non-T1541 systems.

6 Issuing Authority

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7 Publication History

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16 May 2003		Addition of Pooled Channels Feature information and updates to Transmit Inhibit on Busy Channels Feature Information