Cisco Systems Advanced Services

IPICS LMR Gateway Configurations

Version 0.1

Corporate Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 526-4100

Contents

Tables

Figures

1.0 About This Design Document

Author: Mark Vitosh

Cisco Systems, AS

Reference Number: <ASAP/CKC Reference number for final deliverable document.>

1.1 Document Purpose

This document will describe the most common implementation configurations for integrating Land Mobile Radio's with the IPICS network based solution. Although the configurations are intended to outline the most common applications it cannot describe every possible situation.

1.2 Intended Audience

This document is intended as a guide for Cisco Advanced Service.

This document is also intended as a reference for technical staff who are in charge of deploying and maintaining the IPICS solution.

1.3 Scope

This document only details the components of the IPICS LMR gateway solution.

1.4 Document Usage Guidelines

1.5 Assumptions and Caveats

<State your assumptions.>

1.6 Related Documents

<List any related documents (e.g. RFP, RFP response, MSD documentation, etc).>

2.0 Overview

2.1 Interfacing IPICS LMR Gateway with Land Mobile Radio's

Audio connections between the Land Mobile radio and the IPICS solution is accomplished by using a software feature license with Cisco E&M interface cards; these are the same cards used for years to interface telephone switching equipment and Cisco routers. The combination of the feature license and the E&M card creates a LMR radio gateway.

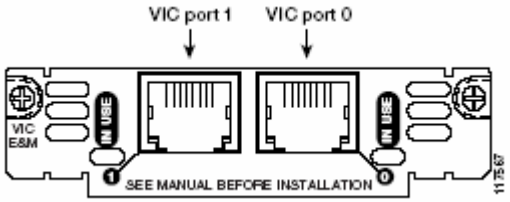


Figure 1 VIC2-2E/M

(VIC2-2E/M) + (FL-LMR) = LMR Gateway

2.2 Cabling

The LMR signaling enhancements in Cisco IOS software are germane to the analog ear and mouth (E&M) interface for LMR signaling only. For a description of how the leads on the analog E&M interface are implemented on Cisco IOS voice gateways, refer to *Understanding and Troubleshooting Analog E&M Interface Types and Wiring Arrangements.* We recommend reviewing this document before reading further.

LMR cable building requires an understanding of the device being interfaced. Some equipment may require components in the cable such as resisitors, capacitors, inductors, or inverters. It is critical that the cable builder understand the LMR side of the cable and what signals are expected to and from the LMR before connecting to the E&M port on the router.

LMR gateway is configured to support 2-wire or 4-wire audio. The audio and control signals enters & exits the E&M port via a RJ-45 jack on the card. The simplest cable is a standard Category 5 Ethernet cable where one end has beeen left unterminated. Stripping back the wire jacket will expose four pairs of wire.

- The Blue pair of wires (Tip-1 & Ring-1) map to pins 4 and 5 on the RJ-45 plug of the E&M card. In 4-wire operation this pair of wires is the outbound audio from the gateway card. The leads are transformer-isolated with an impedance of 600 ohms across each pair, providing a 600 ohm transformer coupled audio appearance to radios. This would typically connect to an external microphone jack or pin on the Land Mobile Radio. In two-wire operation, the Tip-1 and Ring-1 leads are used to carry the full-duplex audio.

- The Green pair of wires (TIP & Ring) map to pins 3 and 6 on the RJ-45 plug of the E&M card. In 4-wire operation this pair of wires is the inbound audio to the gateway card. The leads are transformer-isolated with an impedance of 600 ohms across each pair, providing a 600 ohm transformer coupled audio appearance to radios. This would typically connect to an external speaker jack or pin on the Land Mobile Radio. In two-wire operation, the Tip and Ring leads are not used.

- The Green pair of wires map to pins 7 and 8 on the RJ-45 plug of the E&M card. This pair of wires is used to signal PTT to the Land Mobile Radio. In E&M type II and III signaling polarity must be observed and pin 8 maps to Signal Ground (SG) and pin 7 maps to the "E" lead which is also the PTT connection of the Land Mobile Radio.

- The orange pair of wires maps to pins 1 and 2 on the RJ-45 plug of the E&M card. This pair of wires is optional and will only be used if the Land Mobile Radio provides signaling for Carrier Operated Relay (COR) or Carrier Operated Squelch (COS) functionality. If the Land Mobile Radio does not provide COR/COS output signals then this pair of wires will not be used. In E&M type II and III signaling polarity must be observed and pin 1 maps to Battery Voltage (SB) and pin 2 maps to the "M" lead.

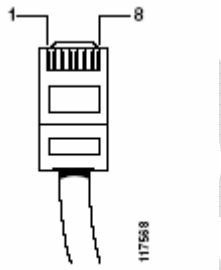


Figure 2 RJ-45 Pinout

Table 1 E&M VIC Pinout

Router RJ-45 Pin #	Router Function	Cat. 5 Color Code	Radio Connection
1	Signal Battery (SB)	Orange	Signal Battery (SB)
2	M-Lead	W/Orange	COR/COS
3	Ring	W/Green	Speaker +
4	Ring-1	Blue	Microphone -
5	Tip-1	W/Blue	Microphone +
6	Tip	Green	Speaker -
7	E-Lead	W/Brown	PTT

8	Signal Ground (SG)	Brown	Ground

2.3 Analog E&M Interface

For analog connections, the E&M interface is the interface card type used to attach the leads from an LMR device. Of all the voice interfaces, only the E&M interfaces can accommodate the variety of different audio and signaling configurations present in the myriad of radio systems out in the field. The E&M port can be configured to transmit and receive audio information using one pair or two pairs of leads. It also has four different configurations for control of the signaling leads. Some radio systems may actually present an E&M interface for their wire-side connections, which obviously simplifies the connection process. However, many others systems will require planning for their connection.

2.4 Analog E&M Signaling Types

Cisco LMR routers support E&M signaling Type II, Type III, and Type V. With each signaling type, therouter supplies one signal, known as the M signal (for Mouth), and accepts one signal, known as the E signal (for Ear). Conversely, the LMR equipment accepts the M signal from the router and provides the E signal to the router. The M signal accepted by the LMR equipment at one end of a circuit becomes the E signal output by the remote LMR interface.

Selects the appropriate E&M interface type (depending on the end connection).

- Type II indicates the following lead configuration:
  - E—Output, relay to SG
  - M—Input, referenced to ground
  - SB—Feed for M, connected to –48V
  - SG—Return for E, galvanically isolated from ground

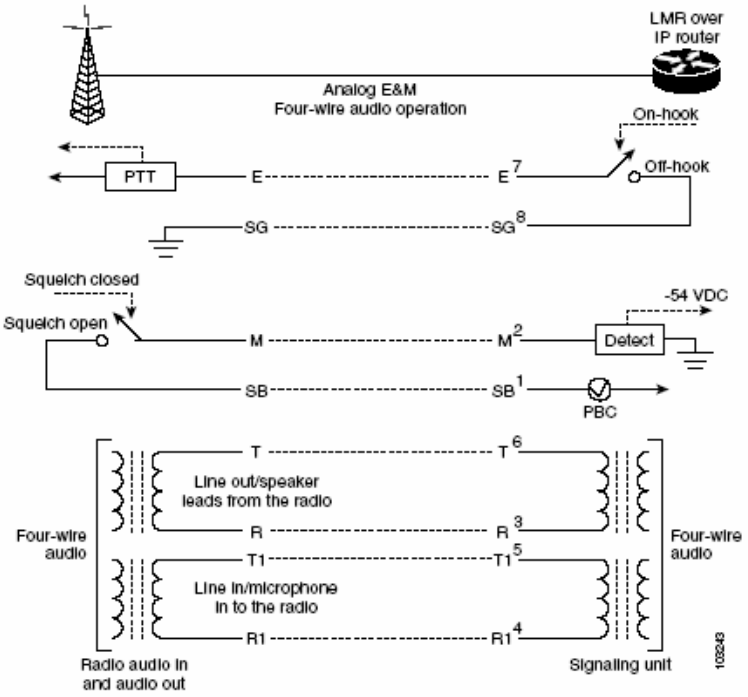


Figure 3 E&M Type II Interface

• Type III indicates the following lead configuration:

- E—Output, relay to ground
- M—Input, referenced to ground
- SB—Connected to –48V
- SG—Connected to ground

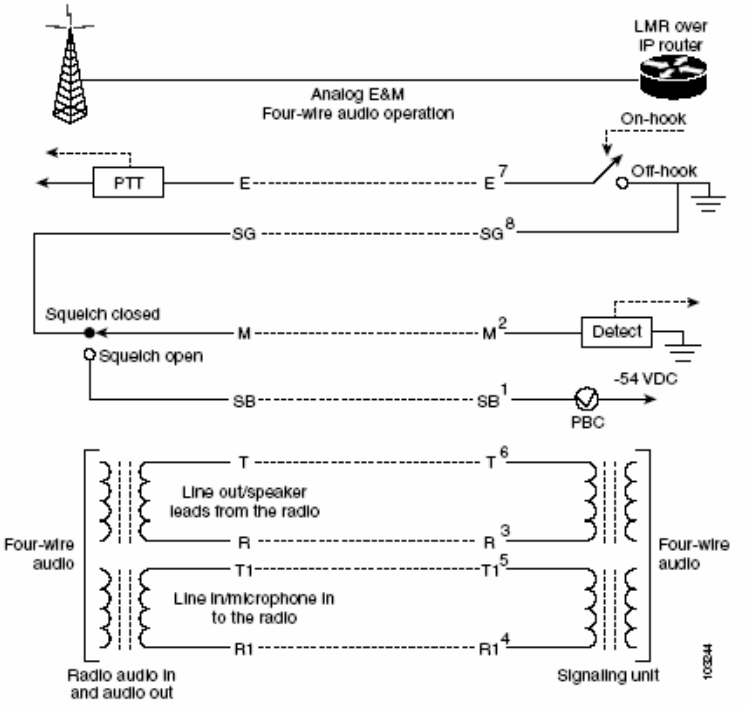


Figure 4 E&M Type III Interface

- Type V indicates the following lead configuration:
  - E—Output, relay to ground
  - M—Input, referenced to –48V

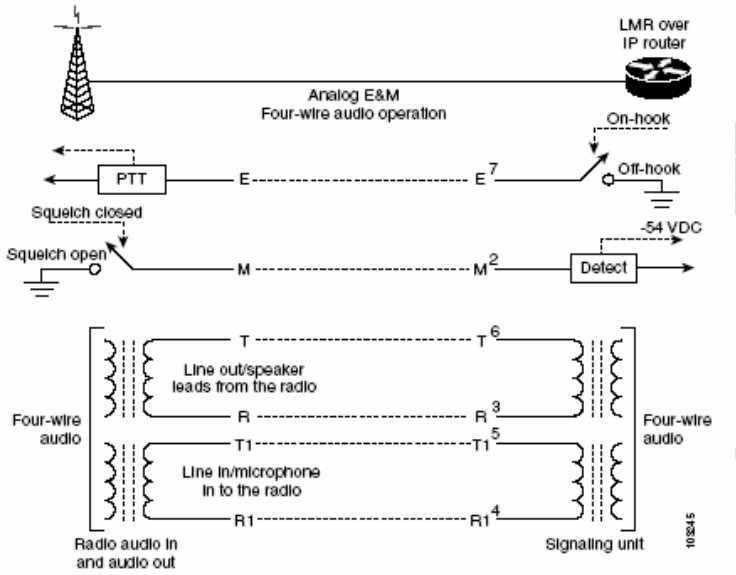


Figure 5 E&M Type V Interface

3.0 IOS LMR Gateway Configurations

3.1 Determining Correct IOS Radio Control

The router configuration and connections will typically be determined by the capabilities of the Land Mobile Radio. Use the router configuration that best matches your situation described in bold letters below.

There are basically 3 types of IOS radio control configurations.

- VAD Operated Signaling
- COR/COS Operated Signaling
- Tone Control Signaling

  - VAD Operated Signaling – **This configuration is typically used when the LMR device does not provide COR/COS signaling.** Without the COR/COS signaling interface from the LMR device the router will use the Voice Activated Detection (VAD) function within IOS to determine when a signal is being received from the LMR device and begin sending VOIP packets on the designated multicast address. Typicaly this option is used when a portable LMR device is the endpoint because normally they do not provide signaling for COR/COS.

  - COR/COS Operated Signaling – **This configuration should be used when the LMR device has the ability to provide COR/COS signaling.** The reason is that the router will only begin sending VOIP packets on the assigned multicast address once this line is activated by the LMR device. Typically this will give you the most reliable audio reception and elliminate the clipping of the beginning of a conversation that may occur when the VAD Operated Signaling function is employed.

  - Tone Control Signaling – **This configuration should be used if the LMR device has a tone control panel interface and uses tone signaling mixed in the audio stream to communicate its activity states to the Land Mobile Radio.** Typically a wakeup tone, frequency/function selection tone, and guard tone will be generated along with the audio to control the LMR device. Normally you will only find this option on base station type LMR devices.

3.2 VAD Operated Signaling Configuration

You must issue the **lmr m-lead inactive** command for VAD Operated Signaling. When this configuration is used the router ignores signals sent by voice on the M-lead. The flow of voice packets is determined by Voice Activity Detection (VAD). Typically 6 of the 8 wires will be employed.

Table ? lists a typical VAD Operated Router/LMR gateway connections.

Table 2 VAD Physical LMR Connections

Router RJ-45 Pin #	Router Function	Cat. 5 Color Code	Radio Connection
1	Signal Battery (SB)	Orange	Not Connected
2	M-Lead	W/Orange	Not Connected
3	Ring	W/Green	Speaker +
4	Ring-1	Blue	Microphone -
5	Tip-1	W/Blue	Microphone +
6	Tip	Green	Speaker -
7	E-Lead	W/Brown	PTT
8	Signal Ground (SG)	Brown	Ground

Cisco voice activity detection (VAD) has two layers: application programming interface (API) layer and processing layer. There are three states into which the processing layer classifies incoming signals:

- speech
- unknown
- silence

The state of the incoming signals is determined by the noise threshold, which can be configured with the **threshold noise** command.

If the incoming signal cannot be classified, the variable thresholds that are computed with the statistics of speech and noise that VAD gathers are used to make a determination. If the signal still cannot be classified, then it is marked as unknown. The final decision is made by the API. In some applications, you could have the noise create unwanted spurious packets (for example, a voice stream) taking up bandwidth. The sound quality of the connection is slightly degraded with VAD, but the connection monopolizes much less bandwidth.

VAD Command States

- Silence State
  - If the voice level is below the noise threshold, then the signal is classified as silence and no VOIP packets are sent over the network.
- Speech / Unknown States
  - Signals classified as Speech and Unknown are sent over the network as VOIP packets.

VAD Aggressive Command States

When the **aggressive** keyword is used with the **vad** command in dial peer configuration mode, the VAD noise threshold is reduced from –78 to –62 dBm. Noise that falls below the –62 dBm threshold is considered to be silence and is not sent over the network.

- Silence / Unkown States
  - If the voice level is below the noise threshold, then the signal is classified as silence and no VOIP packets are sent. Additionally, unknown packets are considered to be silence and are discarded when the **aggressive** keyword is used.
- Speech State
  - Only the incoming signal classified as speech will cause packets to be sent over the network.

Generic router configurations for a VAD Operated Signaling with IPICS:

Table 3 VAD Operated Signaling Configuration with IPICS

```
!
!
ip multicast-routing
!
!
voice class codec 1
 codec preference 1 g729r8
 codec preference 2 g711ulaw
!
voice class permanent 1
 signal timing oos timeout disabled
 signal keepalive disabled
 signal sequence oos no-action
!
!
!
!
interface Loopback0
 ip address 192.168.4.6 255.255.255.255
 ip pim sparse-dense-mode
!
interface Vif1
 ip address 192.168.3.5 255.255.255.252
 ip pim sparse-dense-mode
!
interface FastEthernet0/0
 description $ETH-LAN$$ETH-SW-LAUNCH$$INTF-INFO-FE 0/0$
 ip address 192.168.0.6 255.255.255.0
 ip pim sparse-dense-mode
 duplex auto
 speed auto
!
!
voice-port 0/2/1
 voice-class permanent 1
 auto-cut-through
```

```
 operation 4-wire
 type { 2 | 3 | 5 }
 signal lmr
 lmr e-lead voice
 lmr duplex half
 lmr led-on
 input gain { -27 – 16 }
 output attenuation { -16 – 27 }
 no echo-cancel enable
 no comfort-noise
 timeouts call-disconnect 3
 timeouts wait-release 3
 timing hookflash-in 10
 timing hangover 40
 connection trunk 102
 description VAD Operated Voice Port
 threshold noise -40
!
!
!
!
!
dial-peer voice 102 voip
 destination-pattern 102
 session protocol multicast
 session target ipv4:239.193.1.2:21000
 codec g711ulaw
 vad aggressive
!
!
!
```

3.3 COR/COS Operated Signaling Configuration

When this configuration is used the router employs signals sent by voice on the M-lead pin 2. The M-lead corresponds to the Carrier Operated Relay (COR)/Carrier Operated Squelch of the LMR system, which indicates receive activity on the LMR system. The **lmr m-lead audio-gate-in** command configures the voice port to generate VoIP packets only when a seize signal is detected on the M-Lead. Alternately the router stops generating VoIP packets when the seize signal is removed from the M-lead. So it is important to understand that even if there is audio on pins 3 & 6 coming from the LMR the router will only begin sending VoIP packets on the assigned multicast address if the signal on pin 2 has become active. Typically all 8 wires will be employed.

Table ? list a typical COR/COS operated Router/LMR gateway connections.

Table 4 COR/COS Physical LMR Connections

Router RJ-45 Pin #	Router Function	Cat. 5 Color Code	Radio Connection
1	Signal Battery (SB)	Orange	Signal Battery (SB)
2	M-Lead	W/Orange	COR/COS
3	Ring	W/Green	Speaker +

4	Ring-1	Blue	Microphone -
5	Tip-1	W/Blue	Microphone +
6	Tip	Green	Speaker -
7	E-Lead	W/Brown	PTT
8	Signal Ground (SG)	Brown	Ground

Generic voice port & dial peer configurations for a COR/COS Operated Signaling with IPICS:

Table 5 COR/COS Operated Signaling Configuration with IPICS

```
!
!
ip multicast-routing
!
!
voice class codec 1|
 codec preference 1 g729r8
 codec preference 2 g711ulaw
!
voice class permanent 1
 signal timing oos timeout disabled
 signal keepalive disabled
 signal sequence oos n4o-action
!
!
!
interface Loopback0
 ip address 192.168.4.6 255.255.255.255
 ip pim sparse-dense-mode
!
interface Vif1
 ip address 192.168.3.5 255.255.255.252
 ip pim sparse-dense-mode
!
interface FastEthernet0/0
 description $ETH-LAN$$ETH-SW-LAUNCH$$INTF-INFO-FE 0/0$
 ip address 192.168.0.6 255.255.255.0
 ip pim sparse-dense-mode
 duplex auto
 speed auto
!
!
!
!
voice-port 0/2/0
 voice-class permanent 1
 auto-cut-through
 operation 4-wire
 type { 2 | 3 | 5 }
 signal lmr
 lmr m-lead audio-gate-in
 lmr e-lead voice
 lmr duplex half
 lmr led-on
 input gain { -27 – 16 }
 output attenuation { -16 – 27 }
```

```
 no echo-cancel enable
 no comfort-noise
 timeouts call-disconnect 3
 timeouts wait-release 3
 timing hookflash-in 0
 timing hangover 40
 connection trunk 101
 description COR/COS Operated Voice Port
 threshold noise -40
!
!
!
!
dial-peer voice 101 voip
 destination-pattern 101
 session protocol multicast
 session target ipv4:239.193.1.1:21000
 codec g711ulaw
!
!
!
```

3.4 Tone Control Operated Signaling Configuration

Many conventional radio systems use in-band tone signaling to indicate activity, key the transmitter, and control channel selection. The LMR gateway can be configured to generate these tones to control the radio. There are typically three phases of tone signaling:

- Wakeup tone—A tone of a specific duration and frequency that acts as preamble to base stations to indicate that additional signaling is coming.
- Frequency selection (or control) tone—One of a range of tones used to select a frequency (channel) for the audio.
- Guard tone— A tone of a specific frequency that is maintained as long as there is activity on the channel. This tone indicates that the channel has been seized.

To eliminate the need for tones to be passed across the WAN, this feature provides the capability to inject tones at the gateway. Static tone injection is one fixed sequence of single tones, no more than ten tones or pauses in a given sequence, used on all transmissions from that voice port to the attached LMR system. Static tone injection begins with E-lead activity and ends when the hangover time expires on voice playout. The tone sequence comprises some combination of the following:

- Single tone—Of fixed frequency, duration, and amplitude.
- Pause—Of fixed duration.
- Guard tone—Of fixed frequency and amplitude. To be played out with the voice packet, for the dration of the voice packet.
- Idle tone—To be played in the absence of voice packets. Idle tone and guard tone are mutually exclusive.

If you configure injected tones, be sure to use *the* ***timing delay-voice tdm*** command to configure a delay before the voice packet is played out. Configuring a delay prevents the voice packet from being overwritten by the injected tones. The delay must be equal to the sum of the durations of the injected tones and pauses in the tone-signal voice class.

Table ? list the most common tone control frequencies and the related function.

Table 6 Common Tone Control Frequencies

Tone Frequency	Function Tone	Relative Levels	Tone Duration
2175 Hz	Wake Up	+10dbm	120 msec
1950 Hz	Transmit F1	0 dbm	40 mseec
1850 Hz	Tranmsit F2	0 dbm	40 msec
2050 Hz	CTCSS Monitor	0 dbm	40 msec
2175 Hz	Guard Tone	-20 dbm	Duration of PTT
1750 Hz	Transmit F3	0dbm	40 msec
1650 Hz	Transmit F4	0dbm	40 msec

APPICATION NOTE: If the E&M port is the only device connected to the tone control panel for the LMR then either 2-wire or 4-wire configurations are supported. But if there are additional devices other than a single E&M port connected to the tone control panel then **ONLY** 2-wire tone control configurations are supported. If you try to introduce an IPICS E&M 4-wire configuration into an enviroment with multiple connections, such as consoles that are already exisiting, you may have a sinerio where the PMC will not be able to hear the console transmitting and the console will not hear the PMC transmitting. ***It is highly recommended to use 2-wire tone control if there is a choice. As it results in a more robust solution.***

3.5 2-Wire Tone Control Configuration for Single Frequency

When the tone control panel you are going to interface with is configured for 2-wire operation both the transmit and receive audio and control tones are carried over a single pair of wires. You must issue the **operation 2-wire** command under the voice-port being configured. Typically 2 of the 8 wires will be employed.

APPICATION NOTE: If you configure one port as **operation 2-wire** both E&M ports on the same card will automatically become set to **operation 2-wire**.

Table ? lists a typical 2-wire tone control Router/LMR gateway connections:

Table 7 2-Wire Tone Control Physical LMR Connections

Router RJ-45 Pin #	Router Function	Cat. 5 Color Code	Radio Connection
1	Signal Battery (SB)	Orange	No Connection
2	M-Lead	W/Orange	No Connection
3	Ring	W/Green	No Connection
4	Ring-1	Blue	TX & RX Audio
5	Tip-1	W/Blue	TX & RX Audio
6	Tip	Green	No Connection
7	E-Lead	W/Brown	No Connection
8	Signal Ground (SG)	Brown	No Connection

Generic voice port & dial peer configurations for a 2-Wire Tone Operated Signaling:

Table 8 2-Wire Tone Control Operated Signaling Configuration with IPICS

```
!
!
ip multicast-routing
!
!
voice class codec 1
 codec preference 1 g729r8
 codec preference 2 g711ulaw
!
!
voice class permanent 1
 signal timing oos timeout disabled
 signal keepalive disabled
 signal sequence oos no-action
!
!
!
!
!
!
voice class tone-signal 1950Hz
 digital-filter 2175hz
 inject tone 1 2175 3 120
 inject tone 2 1950 -5 40
 inject guard-tone 2175 -20
!
!
!
interface Loopback0
 ip address 192.168.4.6 255.255.255.255
 ip pim sparse-dense-mode
!
interface Vif1
```

```
 ip address 192.168.3.5 255.255.255.252
 ip pim sparse-dense-mode
!
interface FastEthernet0/0
 description $ETH-LAN$$ETH-SW-LAUNCH$$INTF-INFO-FE 0/0$
 ip address 192.168.0.6 255.255.255.0
 ip pim sparse-dense-mode
 duplex auto
 speed auto
!
!
!
!
!
voice-port 0/2/0
 voice-class permanent 1
 voice-class tone-signal 1950Hz
 auto-cut-through
 signal lmr
 lmr duplex half
 lmr led-on
 input gain 1
 output attenuation 1
 no echo-cancel enable
 no comfort-noise
 timeouts call-disconnect 3
 timeouts wait-release 3
 timing hookflash-in 10
 timing hangover 40
 timing delay-voice tdm 160
 connection trunk 101
 description 1950Hz 2-Wire Tone Controlled Radio
 threshold noise -40
!
!
!
dial-peer voice 101 voip
 destination-pattern 101
 session protocol multicast
 session target ipv4:239.193.1.1:21000
 codec g711ulaw
!
!
!
```


3.6 4-Wire Tone Control Configuration for Single Frequency

When the tone control panel you are going to interface with is configured for 4-wire operation the transmit audio and control tones are carried over one pair of wires and the receive audio is carried on a 2nd pair of wires. You must issue the **operation 4-wire** command under the voice-port being configured. Typically 4 of the 8 wires will be employed.

APPICATION NOTE: If you configure one port as **operation 4-wire** both E&M ports on the same card will automatically become set to **operation 4-wire**.

Table ? lists a typical 4-Wire Tone Control Router/LMR gateway connections:

Table 9 4-Wire Tone Conrol Physical LMR Connections

Router RJ-45 Pin #	Router Function	Cat. 5 Color Code	Radio Connection
1	Signal Battery (SB)	Orange	No Connection
2	M-Lead	W/Orange	No Connection
3	Ring	W/Green	RX Audio
4	Ring-1	Blue	TX Audio
5	Tip-1	W/Blue	TX Audio
6	Tip	Green	RX Audio
7	E-Lead	W/Brown	No Connection
8	Signal Ground (SG)	Brown	No Connection

Generic voice port & dial peer configurations for a 4-wire Tone Signaling with IPICS:

Table 10 LMR 4-Wire Tone Control Configuration with IPICS

```
!
!
!
ip multicast-routing
!
!
voice class codec 1
 codec preference 1 g729r8
 codec preference 2 g711ulaw
!
!
voice class permanent 1
 signal timing oos timeout disabled
 signal keepalive disabled
 signal sequence oos no-action
!
!
!
!
!
!
voice class tone-signal 1950Hz
 digital-filter 2175hz
 inject tone 1 2175 3 120
 inject tone 2 1950 -5 40
 inject guard-tone 2175 -20
!
!
!
```

```
interface Loopback0
 ip address 192.168.4.6 255.255.255.255
 ip pim sparse-dense-mode
!
interface Vif1
 ip address 192.168.3.5 255.255.255.252
 ip pim sparse-dense-mode
!
interface FastEthernet0/0
 description $ETH-LAN$$ETH-SW-LAUNCH$$INTF-INFO-FE 0/0$
 ip address 192.168.0.6 255.255.255.0
 ip pim sparse-dense-mode
 duplex auto
 speed auto
!
!
!
!
!
voice-port 0/2/0
 voice-class permanent 1
 voice-class tone-signal 1950Hz
 auto-cut-through
 operation 4-wire
 signal lmr
 lmr duplex half
 lmr led-on
 input gain 1
 output attenuation 1
 no echo-cancel enable
 no comfort-noise
 timeouts call-disconnect 3
 timeouts wait-release 3
 timing hookflash-in 10
 timing hangover 40
 timing delay-voice tdm 160
 connection trunk 101
 description 1950Hz 4-Wire Tone Controlled Radio
 threshold noise -40
!
!
!
dial-peer voice 101 voip
 destination-pattern 101
 session protocol multicast
 session target ipv4:239.193.1.1:21000
 codec g711ulaw
!
!
!
```

3.7 2-Wire Tone Control Configuration for Two Frequencies

There may be a sinerio where you need to change channels via tone control. There are several methodsto enable a voice port to send different sets of control tones. But the simplest is if you configure multiple voice ports each with their own set of control tones and then physicaly tie the ports together in parrallel with standard RJ-11 cabling & connectors. For instance if the LMR base station uses 1950 Hz for F1 repeater frequency and 1850 Hz for F2 talk around you could configure voice port 0/2/0 for 1950 Hz tone generation and voice port 0/2/1 for 1850 Hz. When you need to transmit & receive on F1 you select dial peer 101 and when you need to transmit receive on F2 you select dial peer 102. Typically 2 of the 8 wires will be employed.

Table ? lists a typical 2-Wire Tone Control Router/LMR gateway connections for 2 frequency tone generation for 1950 Hz & 1850 Hz.

Note: You should never connect any other pins together other than the ones indicated or damage to the E&M VIC may occur. It is recommended that only 2-wire RJ-11 connectors be used if employing this method.

Table 11 2-Wire Tone Control Two Frequency Physical LMR Connections

Router RJ-45 #1 Pin #	Router RJ-45 #2 Pin #	Router Function	Cat. 5 Color Code	Radio Connection
1	1	Signal Battery (SB)	Orange	No Connection
2	2	M-Lead	W/Orange	No Connection
3	3	Ring	W/Green	No Connection
4	4	Ring-1	Blue	TX & RX Audio
5	5	Tip-1	W/Blue	TX & RX Audio
6	6	Tip	Green	No Connection
7	7	E-Lead	W/Brown	No Connection
8	8	Signal Ground (SG)	Brown	No Connection

Generic voice port & dial peer configurations for a 2-wire 2 frequency Tone Signaling.

Table 12 2-Wire Tone Control Two Frequency Configuration with IPICS

```
!
ip multicast-routing
!
!
voice class codec 1
 codec preference 1 g729r8
 codec preference 2 g711ulaw
!
!
voice class permanent 1
 signal timing oos timeout disabled
 signal keepalive disabled
 signal sequence oos no-action
!
```

```
!
!
!
!
!
voice class tone-signal 1950Hz
 digital-filter 2175hz
 inject tone 1 2175 3 120
 inject tone 2 1950 -5 40
 inject guard-tone 2175 -20
!
!
voice class tone-signal 1850Hz
 digital-filter 2175hz
 inject tone 1 2175 3 120
 inject tone 2 1850 -5 40
 inject guard-tone 2175 -20
!
!
!
!
interface Loopback0
 ip address 192.168.4.6 255.255.255.255
 ip pim sparse-dense-mode
!
interface Vif1
 ip address 192.168.3.5 255.255.255.252
 ip pim sparse-dense-mode
!
interface FastEthernet0/0
 description $ETH-LAN$$ETH-SW-LAUNCH$$INTF-INFO-FE 0/0$
 ip address 192.168.0.6 255.255.255.0
 ip pim sparse-dense-mode
 duplex auto
 speed auto
!
!
!
!
!
voice-port 0/2/0
 voice-class permanent 1
 voice-class tone-signal 1950Hz
 auto-cut-through
 signal lmr
 lmr duplex half
 lmr led-on
 input gain 1
 output attenuation 1
 no echo-cancel enable
 no comfort-noise
 timeouts call-disconnect 3
 timeouts wait-release 3
 timing hookflash-in 10
 timing hangover 40
 timing delay-voice tdm 160
 connection trunk 101
 description 1950Hz 2-Wire Tone Controlled Radio
 threshold noise -40
!
```

```
!
voice-port 0/2/1
 voice-class permanent 1
 voice-class tone-signal 1850Hz
 auto-cut-through
 signal lmr
 lmr duplex half
 lmr led-on
 input gain 1
 output attenuation 1
 no echo-cancel enable
 no comfort-noise
 timeouts call-disconnect 3
 timeouts wait-release 3
 timing hookflash-in 10
 timing hangover 40
 timing delay-voice tdm 160
 connection trunk 102
 description 1850Hz 2-Wire Tone Controlled Radio
 threshold noise -40
!
!
!
dial-peer voice 101 voip
 destination-pattern 101
 session protocol multicast
 session target ipv4:239.193.1.1:21000
 codec g711ulaw
!
dial-peer voice 102 voip
 destination-pattern 102
 session protocol multicast
 session target ipv4:239.193.1.2:21000
 codec g711ulaw
 vad aggressive
!
!
```

4.0 Trunked Radio Optional Workaround

4.1 Trunked Radio Feedback Tones

Trunked radios often provide the LMR user beeps & bonks during the beginning and/or end of transmissions. These beeps & bonks give the end user feedback on the status all their request to access a channel, group, or particular radio. If the IPICS user does not receive this feedback information they may think they are transmitting when in fact they have been denied access to the system because it is busy or the particular radio they are trying to contact is not available. In order for the IPICS PMC end point to hear these feedback tones the PMC must operate in a full duplex mode. But if you add a full duplex enabled channel to a Virtual Talk Group (VTG) you risk getting a ping pong audio effect when the trailing burst of audio is received when they disconnect.

Application Note: Only the PMC endpoint can operate in a full duplex mode. The IP Phone XML application will continue to be half duplex.

So the goal is to deal with two conflicting requirements:

- Full duplex is required for an endpoint to hear beeps and bonks.
- Half duplex is required to prevent ping ponging with radios that provide a trailing burst of audio when they disconnect.

4.2 Trunked Radio Hybrid Configuration

In order to allow for beeps and boinks and to prevent ping ponging, you need to create a hybrid solution that creates two separate channels for each trunked radio as follows:

Channel 1 PMC = 239.193.1.4 This is the same multicast address that is assigned to the voice port and dial peer for a radio. This is the channel that you will assign to any users PMC that want to use the trunked channel and get the feedback beeps & bonks.

Channel 1 VTG = 239.193.1.0 This is the channel that you will put in a VTG if you want the trunked radio to be in a VTG.

Now, as you can see, you have an extra "dummy" channel (Channel 1 VTG) that is used to create the hybrid solution.

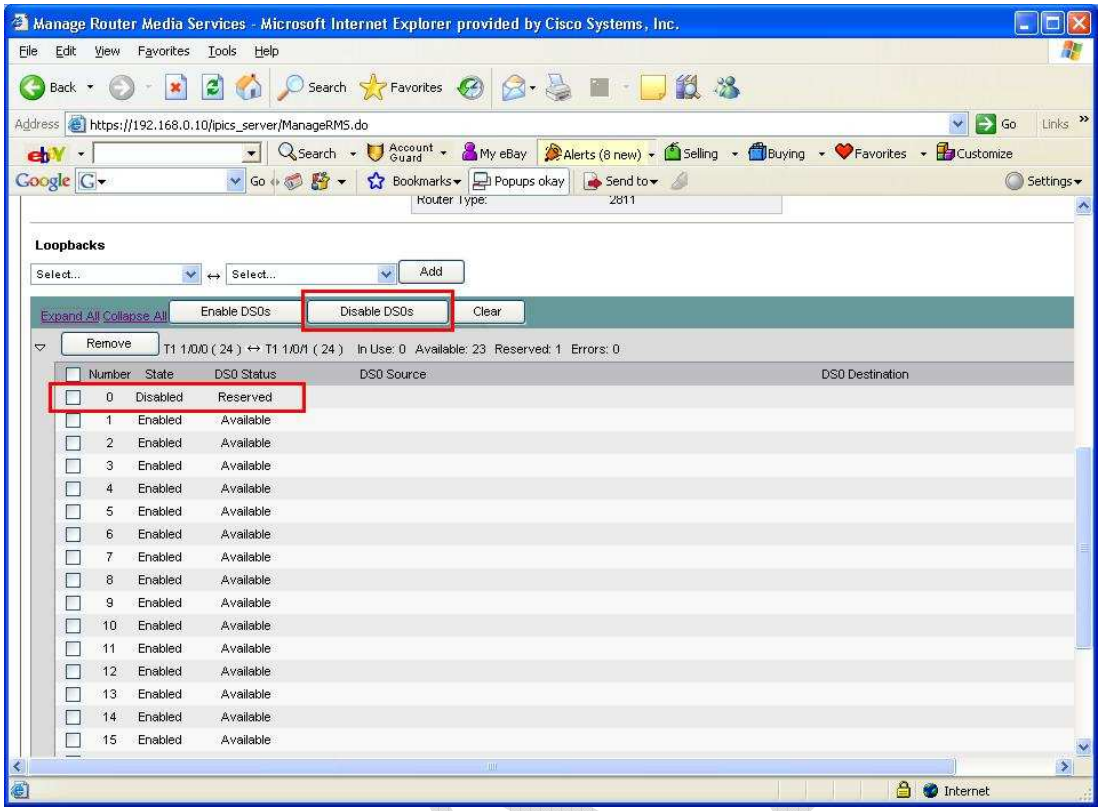
First configure the voice port for the trunked radio using one of the configurations described in section 3.0 that mtaches your radio. The following is an example for a VAD Operated Signaling Configuration for a Nextel I355 Trunked Radio.

Table 13 E&M Voice-Port & Dial Peer for Nextel I355 Configuration with IPICS

```
!
!
!
voice-port 0/3/1
 voice-class permanent 1
 auto-cut-through
 operation 4-wire
 type 3
 signal lmr
 lmr e-lead voice
 lmr led-on
 input gain 16
 output attenuation 17
 no echo-cancel enable
 no comfort-noise
 timeouts call-disconnect 3
 timeouts wait-release 3
 timing hookflash-in 10
 timing hangover 40
 connection trunk 104
 description Nextel I355 Direct Connect
 threshold noise -40
!
!
! Dial Peer For Above LMR
!
dial-peer voice 104 voip
 destination-pattern 104
 session protocol multicast
 session target ipv4:239.193.1.4:21000
 codec g711ulaw
 vad aggressive
!
!
```

Second, in order for the traffic that is associated to 239.193.1.4 to be routed to the dummy channel, you need to set up a manual loopback in the RMS router. You can do this by manually defining the voice ports with dial peers to create the manual "bridge". You will likely be using a voice port pair that is part of one of your T1 loopbacks for the IPICS RMS solution. This means that you need to make sure that it is not an available resource to the IPICS RMS solution by putting it in the “Reserved” state. This is done in IPICS admin, by displaying the RMS details, expanding it, selecting the desired idle channel, then selecting “Deactivate DS0”. Then click save. You will see that the channel is now marked as reserved.

Figure 6 DSO Disabled in IPICS Admin



Once the channel is determined, you can use the following sample configuration and transpose the T1 voice ports as needed. This example assumes a loopback port of **1/0/0:0**<->**1/0/1:0** has been marked as reserved in IPICS and will be used for the manual bridge.

T1 Loopback Left Side Half will be set to **lmr duplex half** (eg. 1/0/0:0) with the Multicast address of channel 1 VTG 239.193.1.0:21000 .

Table 14 T1 Loopback Left Side Example Configuration with IPICS

```
!
!
voice-port 1/0/0:0
 voice-class permanent 1
 auto-cut-through
 lmr m-lead audio-gate-in
 lmr e-lead voice
 lmr duplex half
 no echo-cancel enable
 no comfort-noise
 timeouts call-disconnect 3
 timing hookflash-in 0
 timing hangover 260
 timing delay-voice tdm 260
 timing ignore m-lead 100
 connection trunk 3104
 description Trunk Radio Half Duplex Bridge(Disabled in IPICS)
!
! T1 Loopback Left Side Dial Peer
!
dial-peer voice 3104 voip
```

```
 description Trunk Radio Half Duplex VTG Channel
 destination-pattern 3104
 session protocol multicast
 session target ipv4:239.193.1.0:21000
 codec g711ulaw
 no vad
!
!
```

T1 Loopback Right Side Half will be set to will be set to **no lmr duplex half** (eg. 1/0/1:0) with the Multicast address of channel 1 PMC 239.193.1.4:21000 .

Table 15 T1 Loopback Right Side Example Configuration with IPICS

```
!
!
voice-port 1/0/1:0
 voice-class permanent 1
 auto-cut-through
 lmr m-lead audio-gate-in
 lmr e-lead voice
 no echo-cancel enable
 no comfort-noise
 timeouts call-disconnect 3
 timing hookflash-in 0
 timing hangover 40
 connection trunk 2104
 description Trunk Radio Fulll Duplex Bridge (Disabled in IPICS)
!
!
!  T1 Loopback Right Side Dial Peer
!
dial-peer voice 2104 voip
 description Trunk Radio Full Duplex Bonk Channel
 destination-pattern 2104
 session protocol multicast
 session target ipv4:239.193.1.4:21000
 codec g711ulaw
 no vad
!
!
```

What this bridge will do is allow for you to use channel 1 PMC for endpoints and channel 1 VTG anytime you need to place this trunked radio into a Virtual Talk Group. Since channel 1 PMC is full duplex, endpoints will hear the beeps & bonks. Since channel 1 VTG is half duplex, it will allow for multiple half duplex radio channels (or their dummy partners) to be in VTG's without passing the splash tones back and forth, preventing ping ponging.

Application Note: The end user must also configure their PMC to not "MUTE" the receive audio during PTT on the trunked channel to ensure beeps & bonks are heard.

Appendix I

Compatibility Matrix

Cisco IPICS Versions	1.0(1)	1.0(2)
Release Date	**12/8/05**	**6/1/06**
Supported Cisco IPICS Upgrades		
Standard Support = Last release on the current train and the last maintenance release on the two prior trains.	N/A	1.0(1.1) (1.0(1) + SR1)
Additional Tested Upgrades	N/A	N/A
Cisco Unified CallManager Supported Versions		
Cisco Unified CallManager	Version 4.1(2)	Version 4.1(2)
Cisco CallManager Express Supported Versions		
Cisco CallManager Express	Version 3.4	Version 3.4
Cisco Unified IP Phone Supported Versions		
Cisco Unified IP Phone 7960	Version 7.2(3)	SCCP Version 8.0(2)
Cisco Unified IP Phone 7970	Version 7.0(1)	SCCP Version 8.0(2)SR1
Cisco Unified Wireless IP Phone 7920	N/A	Engineering Special cmterm_7920.4.0-03-00-ENG01.bin [1]
Compatible OS and Platforms		
Software on CD for New Server Installs		
Cisco Linux	Cisco IPICS Operating System	Cisco IPICS Operating System, version 1.0(2)
Cisco IPICS Server Software	Cisco IPICS Server Software, version 1.0(1) with the following components: · Cisco IPICS Administration Console version 1.0(1) · Cisco IPICS Web Application Server (Tomcat Server, version 5.5) · Cisco IPICS Data Store (IBM Informix Dynamic Server, version 10.00.UC1) · Cisco Security Agent, version 4.5.1.639	Cisco IPICS Server Software, version 1.0(2) with the following components: · Cisco IPICS Administration Console version 1.0(2) · Cisco IPICS Web Application Server (Tomcat Server, version 5.5) · Cisco IPICS Data Store (IBM Informix Dynamic Server, ver. 10.00.UC3W5) · Cisco Security Agent, version 4.5.1.639
Supported Cisco IOS Software		
Cisco IOS Software	Cisco IOS release 12.4T	Cisco IOS release 12.4T [2]
Supported MCS Platforms		
MCS-7825-H1-S31	Minimum of 2 GB of memory is required for Cisco IPICS	Minimum of 2 GB of memory is required for Cisco IPICS

MCS-7825-H2-S31	N/A	Minimum of 2 GB of memory is required for Cisco IPICS
MCS-7845-H1-S31	This server ships with 4 GB of memory	This server ships with 4 GB of memory
Supported PMC Hardware and Software		
Hardware	**Minimum Requirements:** · 300 MHz Pentium III class, including Mobile Pentium (NOTE: 600 MHz is recommended) · 256 MB RAM · 16 MB free space · Network interface card	**Minimum Requirements (4-channel PMC):** · 800 MHz Pentium III, including Mobile Pentium · 256 MB RAM, 16 MB free space · Network interface card **Minimum Requirements (8-channel PMC):** · 1.5 GHz Pentium IV, including Mobile Pentium · 512 MB RAM, 16 MB free space · Network interface card **Minimum Requirements (18-channel PMC):** · 3.2 GHz Pentium IV, including Mobile Pentium · 1 GB RAM, 16 MB free space · Network interface card
Software	**Minimum Requirements:** · Windows 2000 Professional SP4, or · Windows XP Professional SP2	**Minimum Requirements:** · Windows 2000 Professional SP4, or · Windows XP Professional SP2
Compatible Cisco Software Applications		
CSA (Cisco Security Agent)		
Cisco Security Agent	Version 4.5.1.639	Version 4.5.1.639
Compatible RMS Gateways and Routers		
Cisco 2811	Cisco IOS 12.4(4)T	Cisco IOS 12.4(4)T
Cisco 3725	Cisco IOS 12.4(4)T	Cisco IOS 12.4(4)T
Cisco 3845	Cisco IOS 12.4(4)T	Cisco IOS 12.4(6)T3 [3]
Supported Interface Cards		
Cisco 2811, 3725, 3845	Cisco 1- and 2-port T1/E1 Multiflex Trunk Voice/WAN Interface Cards: · VWIC-2MFT-T1 · VWIC-2MFT-T1-DI · VWIC2-2MFT-T1/E1 . VWIC-2MFT-E1 . VWIC-2MFT-E1-DI Cisco High-Density Digital Voice/Fax Network Module: · NM-HDV2-2T1/E1	Cisco 1- and 2-port T1/E1 Multiflex Trunk Voice/WAN Interface Cards: · VWIC-2MFT-T1 · VWIC-2MFT-T1-DI · VWIC2-2MFT-T1/E1 . VWIC-2MFT-E1 . VWIC-2MFT-E1-DI Cisco High-Density Digital Voice/Fax Network Module: · NM-HDV2-2T1/E1
MCS Performance/Capacity Metrics		

MCS-7825-H1-S31	· Up to 5000 users defined in the database, with support for up to 1000 concurrent users (any combination of PMC and Cisco IP Phone users) · Up to 40 dispatchers concurrently creating, activating, and deactivating VTGs every 15 minutes · Dispatchers log in with 1 minute intervals; each activation and deactivation occurs between 800 to 1000 seconds (approximately) · Up to 25 users in a single VTG	· Up to 5000 users defined in the database, with support for up to 1000 concurrent users (any combination of PMC and Cisco IP Phone users) · Up to 40 dispatchers concurrently creating, activating, and deactivating VTGs every 15 minutes · Dispatchers log in with 1 minute intervals; each activation and deactivation occurs between 800 to 1000 seconds (approximately) · Up to 25 users in a single VTG
MCS-7845-H1-S31	· Up to 5000 users defined in the database, with support for up to 1500 concurrent users (any combination of PMC and Cisco IP Phone users) · Up to 60 dispatchers concurrently creating, activating, and deactivating VTGs every 15 minutes · Dispatchers log in with 1 minute intervals; each activation and deactivation occurs between 800 to 1000 seconds (approximately) · Up to 35 users in a single VTG	· Up to 5000 users defined in the database, with support for up to 1500 concurrent users (any combination of PMC and Cisco IP Phone users) · Up to 60 dispatchers concurrently creating, activating, and deactivating VTGs every 15 minutes · Dispatchers log in with 1 minute intervals; each activation and deactivation occurs between 800 to 1000 seconds (approximately) · Up to 35 users in a single VTG

Notes:

[1] The Cisco Unified Wireless IP Phone 7920 ES cmterm_7920.4.0-03-00-ENG01.bin is not available on CCO. To obtain a copy of this firmware, send an email to ask-ipics-support@external.cisco.com.

[2] Cisco IPICS supports only the stated Cisco IOS 12.4T release trains, as shown in the "Compatible RMS Gateways and Routers" section; no other versions are supported for use with Cisco IPICS.

[3] Until the production version of Cisco IOS release 12.4(6)T3 is posted on CCO, a special interim version of Cisco IOS software is available to enable support for 3845 RMS routers; this software is provided **only** for Cisco IPICS customers who use 3845 RMS routers. To obtain a copy of this special interim software, Cisco IPICS customers who use 3845 RMS routers should send an email to ask-ipics-support@external.cisco.com with "Request 3845 RMS Special Interim Build" in the subject line. Make sure that the customer name and contact information are included in the email.

Corporate Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 526-4100

European Headquarters
Cisco Systems Europe
11 Rue Camille Desmoulins
92782 Issy-Les-Moulineaux
Cedex 9
France
www-europe.cisco.com
Tel: 33 1 58 04 60 00
Fax: 33 1 58 04 61 00

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-7660
Fax: 408 527-0883

Asia Pacific Headquarters
Cisco Systems Australia, Pty., Ltd
Level 9, 80 Pacific Highway
P.O. Box 469
North Sydney
NSW 2060 Australia
www.cisco.com
Tel: +61 2 8448 7100
Fax: +61 2 9957 4350

Cisco Systems has more than 200 offices in the following countries and regions. Addresses, phone numbers, and fax numbers are listed on the

Cisco Web site at www.cisco.com/go/offices.

Argentina • Australia • Austria • Belgium • Brazil • Bulgaria • Canada • Chile • China • Colombia • Costa Rica • Croatia • Czech Republic Denmark • Dubai, UAE
Finland • France • Germany • Greece • Hong Kong SAR • Hungary • India • Indonesia • Ireland • Israel • Italy • Japan • Korea • Luxembourg • Malaysia • Mexico
The Netherlands • New Zealand • Norway • Peru • Philippines • Poland • Portugal • Puerto Rico • Romania • Russia • Saudi Arabia • Singapore • Slovakia • Slovenia
South Africa • Spain • Sweden • Switzerland • Taiwan • Thailand • Turkey • Ukraine • United Kingdom • United States • Venezuela • Vietnam • Zimbabwe