

# SYNC TO CHANNEL – AC4490 AND CL4490

## **Application Note**

## **INTRODUCTION**

Laird Wireless uses frequency hopping protocol with a fixed pseudo-random hopping sequence on our transceivers. This protocol yields superior interference rejection and multipath immunity. The server radio sends timing beacons out on a regular interval and the clients hear these beacons and synchronize their frequency hopping to the server.

Though servers cannot send packets to each other, they can hear the timing beacons sent out by other servers. Normally, the servers ignore these beacons. However, when Sync to Channel is enabled, and a specific server is designated as the synchronization master, the other servers listen for the beacons from the master server and then synchronize their hop timing to that server.

Why is this important? If two servers (and their clients) are operating in the same area and their frequency hopping is not synchronized to each other, they might try to occupy the same frequency at the same time. In severe cases, they could interfere with each other on every frequency, causing very sluggish communications.

To avoid interference, collocated servers can use Sync to Channel. Sync to Channel synchronizes the frequency hop timing between these servers so that they never occupy the same frequency at the same time.

## **CONFIGURING SYNC TO CHANNEL**

To use Sync to Channel, you should designate one server (preferably the most centrally located server) as the "Hop Master." This server should be programmed to a numerically low RF Channel Number and should have Sync-to-Channel **disabled**. All other servers in the area should have Sync to Channel **enabled** and have their Sync-Channel set to the RF Channel Number of the server chosen as the Hop Master. Preferably, if a server is outside of the range of the Hop Master server it can have its Sync Channel set to the RF Channel Number of another server (with a lower RF Channel Number than its own) that is in range of, and synchronized to, the Hop Master server.

The following rules apply to Sync-to-Channel:

- 1. One server should perform the function of Hop Master.
- 2. The Hop Master server should have its RF Channel Number set to a numerically low value and should have Sync to Channel **disabled**.
- 3. It is preferable to centrally locate the Hop Master server.
- 4. All Servers in the collocated system (those synchronized to the Hop Master server) should have Sync to Channel **enabled.**
- 5. All servers in the collocated system should have their Sync Channel set to a value lower than their RF Channel Number.
- 6. All servers, including the Hop Master server, should have their RF Channel Numbers separated by a minimum of 4-5 Channels (i.e. Server 1, Hop Master = RF Ch 16, Server 2 = RF Ch 21, Server 3 = RF Ch 26...) to avoid inter-channel interference between the radios as they hop through their pseudo-random hopping sequence.
- 7. If the servers to be synchronized are in range of the Hop Master server, it is preferable to set their Sync Channel to the RF Channel Number of the Hop Master server.
- 8. If some of the servers to be synchronized are outside of the range of the Hop Master server, set their Sync Channel to the RF Channel Number of a server (with a lower RF Channel Number than its own) that is in range of, and synchronized to, the Hop Master server.

# Note: All servers with Sync-to-Channel enabled depend on the server designated as Hop Master. If the Hop Master is not powered on and in range, the Sync-to-Channel servers will not synchronize, their LINK LED will not illuminate, and their networks will not communicate.

All collocated servers must be programmed to the same channel set, as shown in Table 1.

Channel Set	RF Channel Number Range (0x40)	Frequency Details & Regulatory Requirements	Countries
0 (CL4490 - 1x1 CL4490 - 200)	0x00 - 0x0F	902 - 915 MHz (26 hop bins)	US / Canada
1 (CL4490 - 1x1 CL4490 - 200 CL4490 - 1000)	0x10 - 0x2F	902 - 928 MHz (50 hop bins)	US / Canada
2 (CL4490 - 1x1 CL4490 - 200 CL4490 - 1000)	0x30 - 0x37	915 - 928 MHz (22 hop bins)	Australia (-1x1/-200/-1000)

What happens if you don't enable Sync to Channel and you have collocated servers? There are good odds that you will see a decrease in throughput due to the systems trying to occupy the same frequency at the same time. In severe cases, you could lose communications all together depending on how much bandwidth your system requires. Due to crystal differences between the servers, you may see intermittent interference. Sync to Channel is pictured in Figure 1 and Figure 2.



Frequency

Figure 1: Two servers without Sync to Channel enabled



Frequency



# How do I configure Sync to Channel?

To configure Sync to Channel, use the Laird Configuration Utility available here.

The installer prompts you to install the software on your PC. Once the install is completed, you can open the software from Start -> All Programs -> Laird Technologies Wireless -> Laird Technologies Config.exe.

#### Note: Items 2-6 in the following list correlate to the numbered items in Figure 3.

- 1. The software opens to the Configure tab. You must change to the PC Settings tab at the top of the window.
- 2. RF Options mentioned in this procedure require that the "Show All Options" box is selected in the Security Pane on the PC Settings tab of the Configuration Utility.

### To enable the Security Pane follow these directions:

- a. From the PC Settings tab, click About.
- b. In the "About" window, click anywhere next to the lines of text. A blinking cursor displays.



c. Type the following in all lower case letters: *showframe!* 

#### Note: Nothing displays on the window when you type.

- d. When you finish typing, the Wireless Configuration and Test Utility window appears and says "Security Frame now visible".
- e. Click **OK** in the Wireless Configuration and Test Utility window.
- f. Click **OK** in the "About" window.
- g. A "Security" section now displays on the PC Settings tab.
- h. Check the Show All Options check box.

ort1 Settings		Ortions		
USB / COM     TCP/ IP Por     Port Status:	A Port Add Find Open Port t Ports Ports Close Port Unavailable	Save Settings on Exit     Freed/Wite with AT Commands     Use Auto Baud/Port		
Eort. Baud Rate	▼ 57600 ▼	Auto Archive EEPROM Settings		
Parity:	None (recommended)	Product	-	
jandshaking:	Hardware (recommended)	Product: Journal of Land		
Data Bits:	8	Disable EEPROM Protection		
Port2 Settings Enabled:		Show All Options		
USB / CON TCP/ IP Por Port Status	Add Find Open Port Ports Ports Close Port Closed			
Port	57800			
Party.	None (recommended)			
(andshaking:	Hardware (recommended)			
Data Bits:	8 ▼ Stop Bts: 1 ▼			
		Abo	.t	

- i. Click the **Configure** tab. The "Radio Features" list now displays the advanced features in the right column.
- j. Click **Read Radio** to populate the advanced feature settings.

Note: For more detailed information on how to enable the security pane, see the Laird Configuration Utility User Manual.

- 3. Select the appropriate product from the Product drop-down menu (Connex4490).
- 4. Select the COM Port that is connected to your radio. If you are unsure, press the **Find Ports** button and the drop down list populates with available COM ports.
- 5. Select the baud rate that matches the baud rate that the radio is programmed to (the default baud rate for the 4490 family is 57600.
- 6. Verify that the COM Port selected is OPEN and that CTS Port 1 is LOW.

W Connex4490 Configurati	on/Test Utility			
Configure	Range Test	Terminal/Chat	Command	PC Settings
Port1 Settings	Id       Find       Open Port         Ports       Close Port         Shack USB to Serial (       •         •       •         nended)       •         Stop Bits:       1         Id       Find         Open Port         Stop Bits:       1         •       •         id       Find       Open Port         Its       Ports       Close Port         •       •       •         •       •       •         •       •       •         •       •       •         •       •       •         •       •       •         •       •       •         •       •       •         •       •       •         •       •       •         •       •       •         •       •       •         •       •       •         •       •       •	Options Save Settings on Exit Read/Write with AT Comman Use Auto Baud/Port Auto Archive EEPROM Settin Monitor UDP for new devices Product Product Connex4490 Security Disable EEPROM Protection Security Show All Options	ids igs s	
L L		€ _	About	
Port1: Open [COM18] [57,600] [8-1	N-1] RTS Port1: High	CTS Port1: Low Port2	2: Unavailable   RTS Port2: H	igh CTS Port2: High

Figure 3: PC Settings tab

7. Go to the Configure tab and click the **Read Radio** button at the bottom right of the screen. A message stating "Read Successful" should appear after a successful read (Figure 4).

configure	Rang	ge Test	Terminal/Chat		Command	PC Settings
Radio Interface			Radio RF			Radio Features
Interface Timeout:	2	Hex	Client/Server:	Client	•	Auto Config
RF Packet Size:	46	Hex	RF Channel Number:	10	Hex	Data Encryption
CTS On:	DC	Hex	Sync to Channel:	1	Hex	Auto Destination
CTS On Hysteresis:	B0	Hex	Max Power:	Full Power	•	Broadcast Mode     Unicast Only
Max Transmit Retries:	10	Hex	System ID:	1	Hex	Auto Channel
Broadcast Attempts	4	Hex	0,001110.			Sync to Channel
Ston Bit Delay:	FF	Hex				RTS Enable
Stop Dit Delay.	48	Hex				Modern Mode
Kange Ketresh:	J	Wireles	s Configuration and T	est Utility 🖡		Protocol Status
						Parity
nfo Center		Read su	uccessful.			Receive API     Enhanced API Enable
Full Duplex:			ОК		lc Baud	Transmit API
[ <u>View in Full Window]</u> In Half Duplex mode, the	transceiver will send a	packe			Hex	Enhanced Receive API
over the RF immediately.	This can cause packets a Client to collide with	sent at the	DES Key: 013 0	29 045 061 077	093 109 Dec	Auto Calibrate
over the RF. To prevent	this, Full Duplex Me	ode can be	Deortoy.			Long Range
enabled. This mode restric numbered frequency "bins"	and the Server to transmitt	ing on odd mitting on	RF Delivery: Addressed			
even frequency bins. Th	ough the RF hardwa	re is still	MAC Address: 00 50 67	93 8A F6		
duplex. This can cause ov	erall throughputs to be	cut in half.	Eirmware Version: V 8.7	7-1		
Note: All transceivers on	the same network mus	st have the	D.O.B.: 5/18/2012			
same setting for Full Dup	JIEX.		Full Part Number: CL4490	-1000-232-01		
GUI View Editor Vie	1		Current: 0 records	found for this ra	dio	
Luitor Vie						

Figure 4: Configure tab - Read Successful

8. To configure the Hop Master, select **Server** and **Broadcast Mode**. Make note of the RF Channel Number (Figure 5). Once the appropriate changes have been made, click **Write Radio**. A Write Successful prompt appears after a successful write. Note that the values are shown using hexadecimal representation; you may change this to decimal notation by double-clicking on the word "Hex" (it changes to "Dec").

		Range Test	Terminal/Chat	Ĭ	Command	PC Settings
Radio Interface			Radio RF	-	-	Radio Features
Interface Timeout:	2	Hex	Client/Server:	Server	-	Auto Config
RF Packet Size:	46	Hex	RF Channel Number:	10	Hex	Data Encryption
CTS On:	DC	Hex	Sync to Channel:	1	Hex	Auto Destination
CTS On Hysteresis:	80	Hex	Max Power:	Full Power	•	Unicast Only
Max Transmit Retries:	10	Hex	System ID:	1	Hex	Auto Channel
Broadcast Attempts:	4	Hex	-			One Beacon Mode
Stop Bit Delay:	FF	Hex				RTS Enable
Rappe Refresh	48	Hex				Modern Mode
						Protocol Status
						Parity
nfo Center			Radio Other			Receive API
Broadcast Mode:		~	Interface Baud: 57600	) 👻	Calc Baud	Transmit API
[View in Full Window] In Broadcast Mode, the tran	caiver will trans-	mit the nacket to	Destination FF FF	FF FF FF FF	Hex	Enhanced Receive API
And a set of the set o	th the same RF	Channel Number	DEC Key 013.0	29 045 061 077 0	93 109 Dec	Send Data Complete
all collocated transceivers with	here is no KF A	Iknowledgement	DES Key. 1			Long Range
all collocated transceivers we and System ID settings. T sent from the recipient(s) bas	ck to the transmi	tter, therefore the				
all collocated transceivers w and System ID settings. T sent from the recipient(s) bas packet is sent out the numb Attempts.	ik to the transmi er of times specif	ed by Broadcast	RF Delivery: Addressed			
all collocated transceivers w and System ID settings. T sent from the recipient(s) ba packet is sent out the numb Attempts.	ik to the transmi er of times specif	ed by Broadcast	RF Delivery: Addressed MAC Address: 00 50 67	93 8A F6		
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all collocated transceivers w and System ID settings. T sent from the recipient(s) bas packet is sent out the numb Attempts. Time to transmit packet = (Full Duplex + 1)	ik to the transmi er of times specif 20ms * Broad	ied by Broadcast	RF Delivery: Addressed <u>M</u> AC Address: 00 50 67 <u>Firmware Version: V 8.7</u> D.O.B.: 5/18/2012 Full Part Number: CL4490	93 8A F6 7-1 9-1000-232-01		
all collocated transceivers w and System ID settings. T sent from the recipient(s) ba packet is sent out the numb Attempts. Time to transmit packet = (Full Duplex + 1) Address Out S bits 1 GUI View EEPROM Editor View	ck to the transmi er of times specif 20ms * Broad	ter, indentore ine led by Broadcast cast Attempts *	RF Delivery: Addressed MAC Address: 00 50 67 Eirmware Version: V 8.7 D.O.B.: 5/18/2012 Full Part Number: CL4490 Current: 0 records	93 8A F6 7-1 0-1000-232-01 found for this rac	lio	<u> </u>

Figure 5: Hop Master settings

9. Configure all radios that will communicate with the Hop Master server as *Client* and *Auto Destination* with the same RF Channel Number as the Hop Master server. Then click **Write Radio**.

Configure		Range Test	Terminal/Chat		Command	PC Settings
Radio Interface			Radio RF			Radio Features
Interface Timeout:	2	Hex	Client/Server:	Client	-	Auto Config     Full Duplex
RF Packet Size:	46	Hex	RF Channel Number:	10	Hex	Data Encryption
CTS On:	DC	Hex	Sync to Channel:	1	Hex	Auto Destination     Broadcast Mode
CTS On Hysteresis:	80	Hex	Max Power:	Full Power	•	Unicast Only
Max Transmit Retries:	10	Hex	System ID:	1	Hex	Auto Channel
Broadcast Attempts:	4	Hex				Cone Beacon Mode
Stop Bit Delay:	FF	Hex				RTS Enable
Range Refresh:	48	Hex				T 485 DE/RE
						Protocol Status
Auto Destination: [View in Full Window] To simplify EEPROM pro- be enabled in Clients automatically set its Destins Server upon receiving the S	gramming, Auto which allows ation Address to t erver beacon.	Destination can the Client to he address of the	Interface Baud: 5760 Destination FF F DES Key: 013	0  F FF FF FF FF 029 045 061 077 0	Calc Baud Hex	Enhanced API Enable     Transmit API     Enhanced Receive API     Send Data Complete     Auto Calibrate     Long Range
Address: 0x56, bit: 4 Enable: 1, Disable: 0 Default: Disabled Version: 1.7 and higher		×	RF Delivery: Addressed <u>M</u> AC Address: 00 50 6 <u>F</u> irmware Version: V 8 D.O.B.: 5/18/2012 Full Part Number: CL449	7 93 8A F6 7-1 0-1000-232-01		
GUI View EEPROM Editor View	~		Current: 0 records	found for this rac	dio	
Port 1 Port 2	Pair	ring Show De	fault Compare EE L	ad File Save	to File Print	Write Radio Read Rad

Figure 6: Client settings

10. Configure server #2 as *Server* and *Broadcast Mode* with an RF Channel Number at least 4-5 steps above the RF Channel Number of the Hop Master. Under the *Radio Features* section, check the **Sync to Channel** box and in the *Radio RF* section, set the Sync to Channel to the RF channel of the Hop Master (Figure 7). Click **Write Radio** to write the changes to the radio's EEPROM.

Configure	Range Test	Terminal/Chat	Command	PC Settings
adio Interface		Radio RF		Radio Features
Interface Timeout:	2 Hex	Client/Server:	Server 💌	Auto Config     Eul Dupley
RF Packet Size:	46 Hex	RF Channel Number:	15 Hex	Data Encryption
CTS On:	DC Hex	Sync to Channel:	10 Hex	Auto Destination
CTS On Hysteresis:	B0 Hex	Max Power:	Full Power	Unicast Only
Max Transmit Retries:	10 Hex	System ID:	1 Hex	Auto Channel
Broadcast Attempts:	4 Hex			Cone Beacon Mode
Stop Bit Delay:	FF Hex			RTS Enable
Range Refresh:	48 Hex			485 DE/RE
				Protocol Status
				Parity
nfo Center		Radio Other		Receive API
Sync Channel	~	Interface Bourt 57600	Calc Baud	
[View in Full Window]		Internace Daud. Jos co		Enhanced Receive API
These transceivers use freq	vency hopping protocol with a	Destination	FF FF FF FF Hex	Send Data Complete
axed pseudo-random hoppir superior interference rejectio	ig sequence. This protocol yields n and multipath immunity. The	DES Key: 013 0	29 045 061 077 093 109 Dec	Auto Calibrate
Server radio sends timing b	eacons out on a regular interval.			Long Range
The Clients hear these	beacons and synchronize their			
requirely nopping to the Se		RF Delivery: Addressed	00.04.50	
Though Servers cannot sen	d packets to each other, they can	MAC Address: 00 50 67	93 0A F6	
the start and the start	escons sent out by the other	Einnware version: V 8.	-1	
hear the timing beacons sent they simply ignore the h		Eul Part Number: CL 4400	1000 222 01	
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hear the timing beacons sent they simply impose the t		Current: 0 records	found for this radio	<b>N</b>
Hear the timing beacons sent they simply innore the to sull View EEPROM Editor View	v N		found for this radio	<u>)</u>

Figure 7: Server #2 settings

11. Configure the radios that will communicate with server #2 as *Client* and *Auto Destination* and with the same RF Channel Number as server #2 (Figure 8). Click **Write Radio** to write the changes to the radios EEPROM.

Configure	Range	Test	Terminal/Chat	Ĭ /	Command	PC Settings
Radio Interface			Radio RF			Radio Features
Interface Timeout:	2	Hex	Client/Server:	Client	•	Auto Config
RF Packet Size:	46	Hex	RF Channel Number:	15 ┥	Hex	Data Encryption
CTS On:	DC	Hex	Sync to Channel:	10	Hex	Auto Destination
CTS On Hysteresis:	80	Hex	Max Power:	Full Power	-	Unicast Only
Max Transmit Retries:	10	Hex	System ID:	1	Hex	Auto Channel
Broadcast Attempts:	4	Hex				Cone Beacon Mode
Stop Bit Delay:	FF	Hex				RTS Enable     Modern Mode
Range Refresh:	48	Hex				485 DE/RE
Info Center Auto Destination:		~	Radio Other		Calc Baud	Enhanced API Enable     Transmit API
Auto Destination: [View in Full Window]		-	Interface Baud: 5760		Caic Baud	Transmit API     Enhanced Receive API
To simplify EEPROM pro be enabled in Clients	gramming, Auto Destina which allows the C	ition can lient to	Destination 1110	29 045 061 077 0	103 109 Dec	Send Data Complete
automatically set its Destina Server upon receiving the Se	ation Address to the addre erver beacon.	iss of the	DES Key: 0130	23 043 001 017 0	555 105 060	Auto Calibrate
Addamas CarSE bin d			RF Delivery: Addressed			
Enable: 1, Disable: 0			MAC Address: 00 50 67	93 8A F6		
Version: 1.7 and higher			Eirmware Version: V 8.3	7-1		
		<u>×</u>	Full Part Number: CL4490	)-1000-232-01		
GUI View EEPROM Editor View	w		Current: 0 records	found for this rac	dio	<u>) (</u>
				1		1 1

Figure 8: Client settings

- 12. Repeat Step 10 for each server that needs to synchronize to the Hop Master; if the server will not be in range of the Hop Master server, set its Sync to Channel to the RF Channel Number of another synchronized server that is in range of the Hop Master (make sure the RF Channel Number of the server is higher than the Sync to Channel).
- 13. Repeat Step 12 for all clients that you wish to communicate with each server from Step 12.

## I've configured my radios, what's next?

Once you have configured all radios, set up your network similarly to the one shown in Figure 9. The main server or Hop Master must be powered on anytime that the other servers are connected to enable them to synchronize and communicate with their clients. If a centralized network does not work and all servers are not in range of the Hop Master, use a daisy chain network as shown in Figure 10.



Figure 9: Sample Centralized Sync to Channel Network configuration



Figure 10: Sample Daisy Chain Sync to Channel Network configuration