Advanced Frequency Hopping “FH” technology used for Circuit Design's 2.4 GHz embedded telecommand module NK-2.4Y

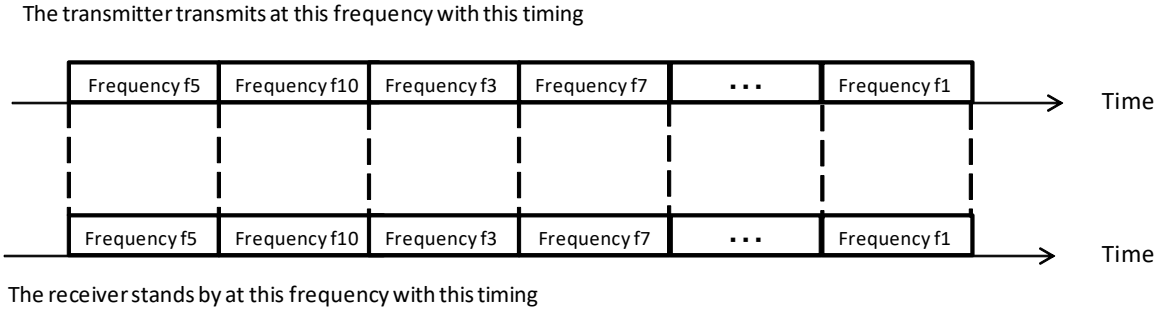
The attraction of 2.4 GHz ISM band telecommand transmitters

Anybody around the world can use 2.4 GHz band (ISM band) wireless devices, so telecommand transmitters that make free use of the ISM band while coexisting with existing WLAN and Bluetooth devices are very attractive for industrial applications, and there’s a strong market requirement for them.

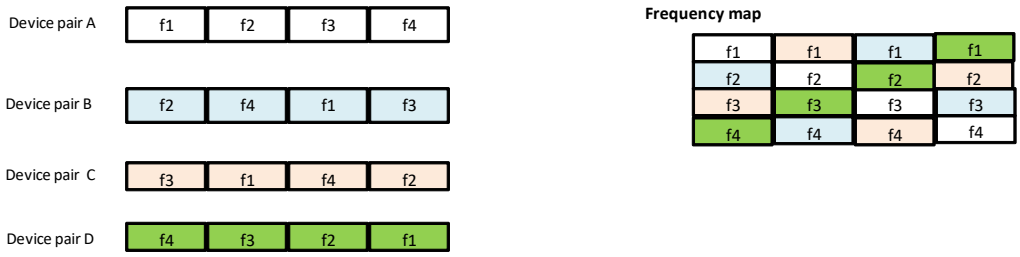
Circuit Design has developed the NK-2.4Y telecommand module using FH (frequency hopping) that offers stable communication in the 2.4 GHz band. The NK-2.4Y conforms to the U.S. FCC, Canadian ISED, European EN, and Japanese ARIB standards. Based on this module, you can easily build radio systems for use in industrial remote switching applications worldwide.

Why can several units be used in the same area without competing with other devices?

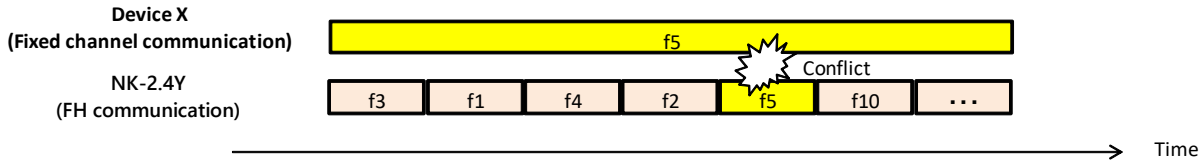
FH is a system that transmits data by switching between frequency channels used for communication between the transmitter and receiver. The NK-2.4Y switches randomly between several dozen channels when transmitting data.
If the transmitter and receiver adopt the same frequency hopping rule (for example f5, f10, f3, f7 ... f1) for transmission, the data can be received correctly.



In addition, **many transmitter receiver pairs can communicate freely at the same time if their frequency hopping rules differ.**



So how do devices with different communication methods coexist?
For example, suppose that Device X is operating in the specific frequency f5 and the NK-2.4Y starts communication using FH. As shown in the diagram below, when the NK-2.4Y selects f5, the signals conflict, but when it selects other frequencies, it can communicate normally. When they conflict, neither Device X nor the NK-2.4Y can communicate. Device X is jammed, so it resends the data from the time the conflict occurred, and the NK-2.4Y restarts sending the specified data when it moves to f10.



In this way, the NK-2.4Y doesn't occupy a specific frequency channel. Instead, it hops from one channel to another such as f10, f3 and so on. In effect, it searches for a vacant frequency channel in which to transmit data.
This is why the **NK-2.4Y can operate in the same area as devices that use different communication methods such as WLAN and Bluetooth**.

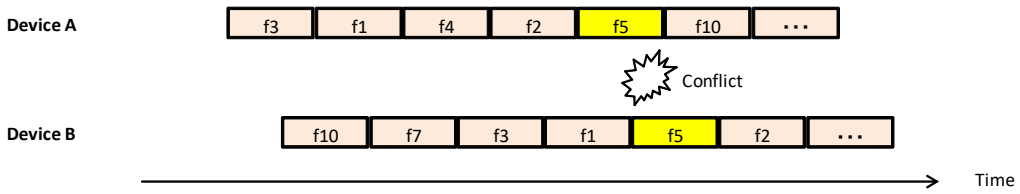
More specifically, let's consider the situation where the signals of spread spectrum systems such as WLAN and Bluetooth are present.

Past WLAN systems used DSSS to send a single unit of data using several frequencies so, as mentioned before, even if some specific frequencies conflict with the NK-2.4Y, the WLAN can transmit data correctly. (Due to the correlation function used for DSSS, if it can communicate using several spread frequencies, there's no problem if some frequencies are in conflict).
The impact of these conflicts depends on the number of WLAN devices operating in the area, but the only effect is the drop in communication data rate, since the number of resends increases.

Bluetooth devices use FH as the NK-2.4Y, so the situation is slightly more complicated.
With the Bluetooth device, if a conflict occurs when it selects the same frequency as the NK-2.4Y, the Bluetooth device increases its resend rate, so its overall data rate decreases.
As a rule, Bluetooth uses 79 channels, and the NK-2.4Y uses 20 channels, so if resending occurs, the data rate would drop by 25% in the worst case scenario.
However, devices since Bluetooth V1.2 have been equipped with an AFH (Adaptive Frequency Hopping) function which selects frequencies that other devices aren't using. Since this prevents decreased data rates due to conflict and resending, the coexistence of Bluetooth devices with the NK-2.4Y is less problematic than if it was with WLAN.

The features of advanced FH technology

As explained above, devices using FH hop between frequencies using a random pattern that differs from other devices.
However, in an environment where several units are being used in the same area, each device is operating with timing independent from the others, so Device A will occasionally select the same frequency channel as Device B, C and so on. This is called a channel conflict. With FH, this can't in principle be avoided.



A feature of the advanced FH technology developed by Circuit Design is that the probability of a channel conflict is equalized for any device at any time.

One advantage of advanced FH technology is that even if channel conflict occurs, at the next frequency channel hop, it takes measures to prevent continuous channel conflicts.
Consequently, even in an environment where multiple NK-2.4Y units are operating, we've achieved the ability to maintain a standard irregularity in response time (ensuring responsiveness) due to the channel conflicts unique to FH.

Another advantage of advanced FH technology is that it offers optimal coexistence with DSSS WLAN devices as well as devices that use FHSS such as Bluetooth, whose timing is independent from the NK-2.4Y.

As explained above, the NK-2.4Y can use frequencies equally, and since the same frequencies are not selected sequentially, it's possible to maintain the lowest frequency channel conflict rate at all times in relation to Bluetooth and WLAN devices which operate asynchronously with the NK-2.4Y.

Conclusion

Industrial radio devices are used in factory or city environments, so they're subject not only to unexpected interference from other equipment but also to fading and other changes in the RF environment.

Consequently, when using industrial radio devices, it's considered normal to set and manage the channels. Furthermore, when the RF propagation suffers, it is necessary for the user to find and switch to an empty channel or restart operations and so on.

Circuit Design's NK-2.4Y uses advanced FH technology which hops randomly between frequencies, so **setting and managing channels is unnecessary**. In addition, it also enables highly reliable radio devices offering **the continuity of communication** and **responsiveness and operability** required for industrial remote switching applications,

Revision history

Version	Date	Description	Remark
1.0	Jul.14, 2016	First edition	
1.1	Jun. 05, 2026	Removal of spread spectrum "SS" WLAN and DSSS explanation rewritten.	