Operational Description

This product, SWK-8650RT, is a 2.4GHz RF KEYBOARD. The product operates in 2400 to 2483.5 MHz band. This product uses the adaptive frequency hopping spread spectrum technology. The number of hopping channels available is 64 and four hopping channels are used for RF communication. If an error in RF communication occurs or radio interference is detected at the one of the four hopping channels, the four channels are hopped to another hopping positions.

Channel Number	Operating frequency (kHz)	Remark
1	2403499.969	Lowest channel
2	2404712.372	
3	2405924.774	
···	···	···
32	2441084.442	
33	2442296.844	Center channel
34	2443509.247	
···	···	···
62	2477456.512	
63	2478668.915	
64	2479881.317	Highest channel

Communication Specification

Frame time (period): 8 ms

Transmission duration: approximately 720 μs

Network method: Time division multiple access

Data rate: 250 Kbps

Number of bytes per packet

Preamble: 32 bit

Sync word: 32 bit

Network ID: 32767(15 bit)

USB Dongle (Base station): 12 byte

Keyboard: 11 byte

Mouse: 8 byte

Power source

The product is powered from two alkaline batteries, DC 3 V.

Antenna

The product has an integrated PCB patch antenna. No external ground is required.

1. RadioDesk™ protocol (SWK-8650RT protocol)

1.1 Overview

The RadioDesk™ protocol is an advanced protocol for wireless HID devices and includes adaptive frequency hopping. The protocol was based on the following design criteria:

- Coexistence with existing 2.4 GHz systems
- Use of ultra-low-cost MCUs
- Long battery life time
- Low latency

RadioDesk™ has been designed to be easily customizable to the implementer's requirements. It can support a variable number of peripherals, various data formats, both one-way and two-way RF links and so on.

RadioDesk™ is a master-slave protocol. In a standard wireless mouse or keyboard system, the USB or PS/2 dongle will be the master and the other devices will be slaves. To save power, the protocol has been designed for asymmetric power consumption. It is assumed that the master has a plentiful source of power, while the slaves are power-constrained. This holds true in most HID systems.

RadioDesk™ uses time-division multiplexing (TDMA) to support multiple devices. A big advantage of the TDMA approach is that it provides infinite attenuation between the various devices, unlike a CDMA or FDMA approach, where differing signal strengths can cause problems. A frame is divided into n+2 time slots, where n is the number of slaves in the system. In the first time slot, the master transmits a beacon. This beacon serves three purposes; it allows for data transfer from the master to the slaves, inform the slaves of the network status, and allow the slaves to synchronise their timing to the master.

After the beacon, the slaves transmit data to the master if they have data to report. The last time slot is used by the master to scan a channel for use in the frequency adaptivity.

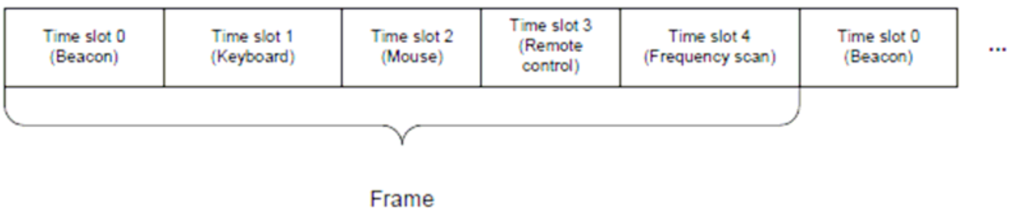

Figure 1. Basic RadioDesk™ frame structure

Figure 1 shows how this looks in a system with three slaves; a keyboard, a mouse and a remote control. Once a frame is complete, the next frame follows immediately afterwards.

The slaves can power-down at any time, they are not required to respond to the beacon unless they have data to report.

1.2 Terminology

As described above, the basic protocol period starting with a beacon and ending just before the next beacon is called a *frame*. Each frame is sent and transmitted on a new channel in the frequency hopping sequence.

A frame is divided into *time slots*. There is sufficient space in a time slot to transmit or receive a single packet. Each time slot is dedicated to a single unit. The time slots are per definition one PTU (Protocol Time Unit) long.

A *packet* contains data that is sent from one unit to another. It consists of a preamble, sync word and payload data followed by a CRC. The packet format is described in more detail later on.

A *channel* is a logical number applied to a physical frequency. RadioDesk uses up to 64 channels, numbered from 0 to 63, even though the physical frequencies used for each channel may vary depending on the implementation.

Active channels are the 4 channels that are active in the frequency-hopping scheme.

1.3 Physical layer

RadioDesk™ is designed to operate in the worldwide, 2.4 GHz license free frequency band, but could be ported to work at other frequencies.

RadioDesk™ is designed to operate with a RF data rate of 250 kbps. The RadioDesk™ reference design uses the CC2500 transceiver and utilizes MSK as modulation method. It is easy to modify the system to operate at different data rates. One very simple modification is to increase the data rate to 500 kbps.

RadioDesk™ can also be implemented on other RF transceivers. For instance, some implementers may want to utilize an IEEE 802.15.4 compatible radio such as the CC2420. The data rate is the same, but the number of total channels need to be reduced. Other than that, the software may be left essentially unchanged.

Parameter	**Allowed range**	**Unit**
Frequency range	2401-2464	MHz
Frequency spacing	1	MHz
Data rate	250 (500 if FEC is to be used)	kbps
Modulation	MSK	
PLL lock time / start time from IDLE (blanking period)	<192	µs
PTU	2000	µs
Spread spectrum technique		Adaptive frequency hopping
Number of channels used		4 active, selected

Table 1. Basic physical layer parameters

1.4 Frequency hopping

RadioDesk™ is an adaptive frequency hopping protocol. Both the master and the slaves change frequency for each frame.

RadioDesk™ uses four active frequencies at any one time. These are selected from a set of 64 possible channels. The master scans through all 64 channels continuously, at a rate of one channel each frame. If one of the active channels has significantly worse performance than the best non-active channel, then the master switches out the bad channel with the good one. To ensure that the active channels are not so close together that a single wide-band interferer could jam all of them at once, there is a limitation on the channel selection algorithm.

The frequency hopping is controlled by a 15-bit pseudo-random sequence. This sequence has a length of 32767 bits. Since 32767 is not divisible by 2, and 2 bits are used to determine the channel used, the RadioDesk™ hopping sequence will only repeat after 32767 hops have been made. The pseudo-random sequence can be implemented as a 15-bit shift register with the appropriate XOR feedback. By setting the shift register to a value, it is possible to select a position in the sequence. This is called the *seed* by analogy to random number generator algorithms. Two units can ensure that they are at the same place in the sequence by comparing the value of the entire shift register. The seed is transmitted in beacon packets so that slaves can synchronise with the pseudo-random sequence of the master.

The implementer might choose to use a purely sequential switch between the four active channels. This would make the two seed bytes in the beacon redundant.

1.5 Data flow

The master transmits a beacon packet in the first time slot of each frame. The beacon packet contains protocol status information and data which the master wants to communicate to the slaves. In a system where the master needs to transmit more data to the slaves than there is place for in the beacon packet, there are two possibilities: Either the time slot length can be extended or an extra time slot can be added for beacon transmission.

When a slave has data to transmit, it listens for a beacon and then transmits a packet in its dedicated time slot. To listen for beacons is not mandatory for a slave; it is free to go into power-down mode at any time to save power. In addition, the slaves do not need to transmit a packet if they do not have data to provide. If a slave transmits data to the master, the master will use the acknowledge bits in the next beacon to confirm the data transfer. If the appropriate acknowledge bit is not set, the slave can retransmit the packet in the next frame.

Figure 2 shows a typical RadioDesk™ usage scenario.

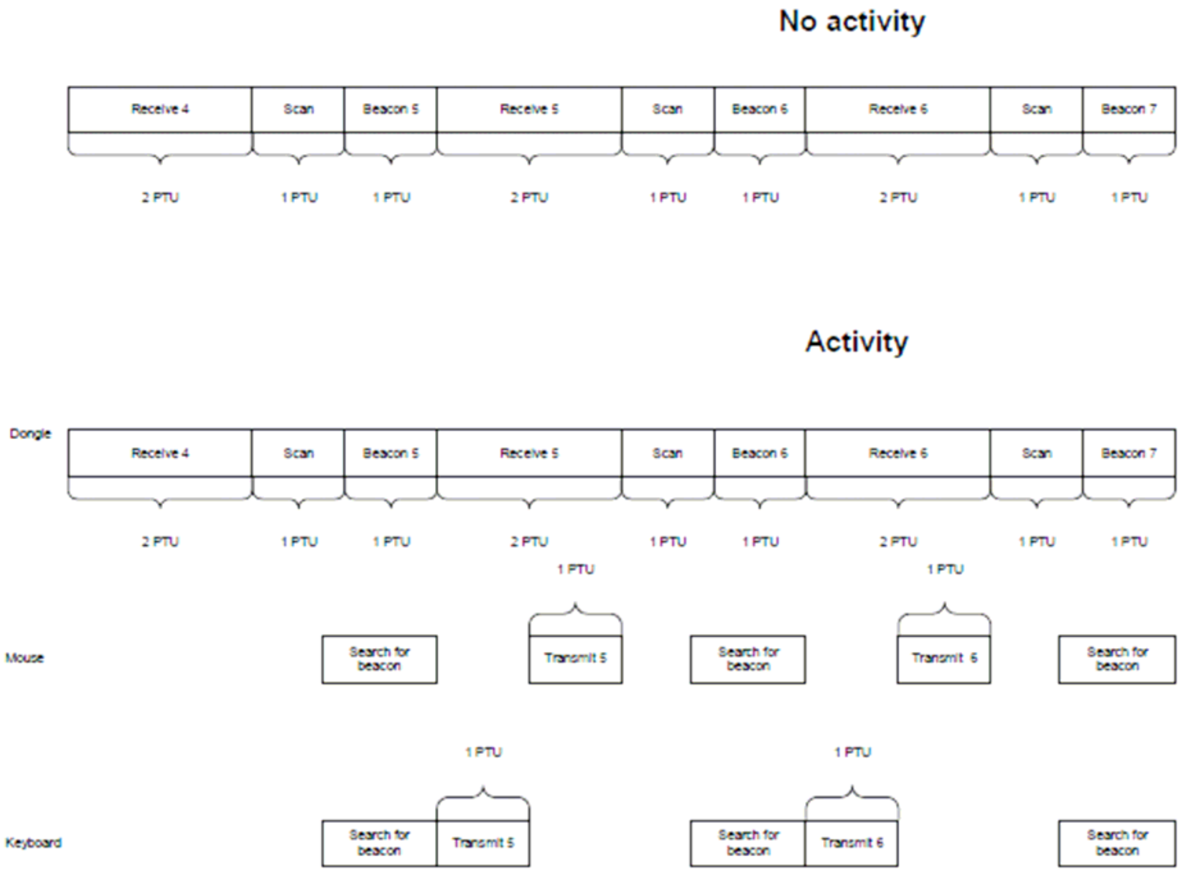

Figure 2. Typical RadioDesk™ data flow