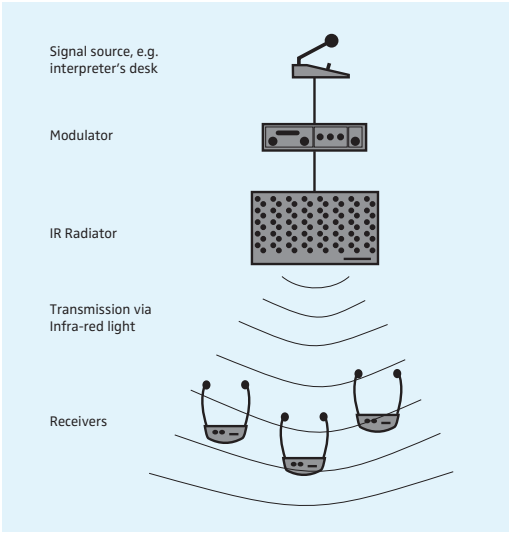
Signal Path/Modulators/Radiators

IR Audio Transmission Technology | Introduction



Signal path in an infra-red transmission system

The SI 1015 and SI 29-5 modulators

The SZI 1015 and SZI 1029 radiators

Signal Path

Theory is no use without practice – but a little theory helps to cast some light on the otherwise invisible phenomena of infra-red technology. Let's start with the signal path in an infra-red audio transmission system.

It all begins with the **signal source**. This can be an interpreter's desk, a conference system, or any other audio system. They all produce an electrical signal which contains the audio information.

This signal is fed to the **modulator** via audio cables. The modulator prepares the audio signal for the subsequent infra-red (IR) transmission.

This processed electrical signal is then fed to the **radiator** via a special cable. The radiator diodes produce the infra-red light and radiate it into the room.

Within this room the light signal can be received by any amount of **receivers**. The receiver converts the light signal back into an electrical signal, and the receiver's headphones make it an audio signal again.

Modulators

The SI 1015 modulator can process one stereo or two mono audio signals for almost any number of radiators. The SI 2 9-5 multi-channel system works differently. You can transmit up to 5 channels per modulator. By interconnecting several SI 2 9-5, you can transmit up to a maximum of 32 channels. Some infra-red radiators have an integrated modulator, for example the SZI 1015-T. With this feature you do not need an "external" modulator such as the SI 29-5 or SI 1015.

Radiators

Radiators transmit the processed audio signal from the modulator. The type and number of radiators determine the area of coverage. Depending on your application, you can choose between models with a higher or lower radiating power. The SZI 1029, for example, is a high-power radiator. Its 132 transmitting diodes can cover an area of up to 800 m (2624.67 ft) . (The 10-Watt SZI 1029-10 will cover double this area).

The SZI 1015 is a power radiator for medium-sized applications. It has an IR radiating power of 2 W and can cover areas of up to 400 m (1313.33 sq ft)..

Receivers/Multi-Channel Systems

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HDI 380 headphone receiver, HDI 302 stethoset receiver, EKI 1029 bodypack receiver

Receivers

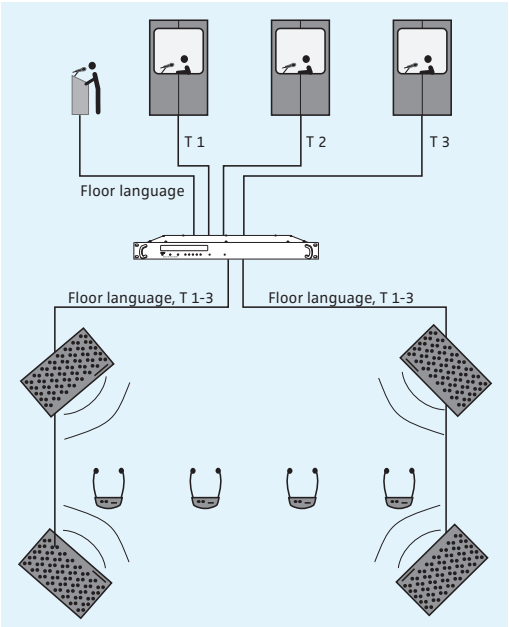
There are three basic IR receiver designs: headphone receivers, stethoset receivers and bodypack receivers without integrated headphones. Depending on the model, the receivers can be switched between up to 32 channels.

The HDI 380 **headphone receiver** has been designed for high-quality hi-fi stereo reproduction, and is therefore the ideal choice for music transmissions.

Stethoset receivers are easy to use and comfortable to wear. They make an ideal choice for conferences, theatres, churches and all other places where audio signals are to be transmitted without cords and without disturbing others.

Bodypack receivers do not have integrated headphones and can therefore be adapted flexibly to a multitude of applications. You can for example connect headphones, unobtrusive earphones or induction couplers for use with a hearing aid.

Every receiver is fitted with a special plastic lens for focussing the IR light onto the photodiode underneath it. A black filter on the photodiode reduces the impact of extraneous, "visible" light. All Sennheiser receivers are powered by an economical and environmentally friendly rechargeable accupack.



Signal path in a multi-channel system

Multi-Channel Systems

An infra-red multi-channel system – here, for example, a four-channel (three-language) simultaneous interpretation system – works as follows: Via audio cables, a total of four signals, i.e. the microphone signal (floor language) and the signals from the three interpreter's desks (translations 1 – 3) are fed to the central unit of the interpretation system and to the inputs of an SI 29-5. The SI 29-5 will prepare the audio signals so that they can subsequently be transmitted by IR radiators. The mixing stage in the SI 29-5 mixes the four audio signals, so that the two BNC output sockets deliver an identical signal to the IR radiators. The IR radiators are ideally mounted close to the ceiling, with a slight downward inclination, so that the entire room is covered uniformly. The only thing that is left for the participants to do is to select the appropriate channel on their receivers.

Frequencies/Modulation

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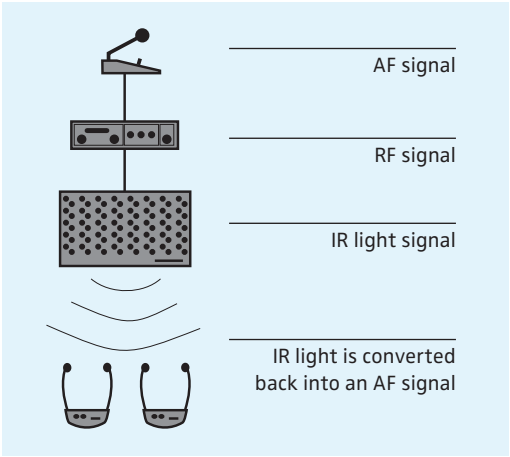
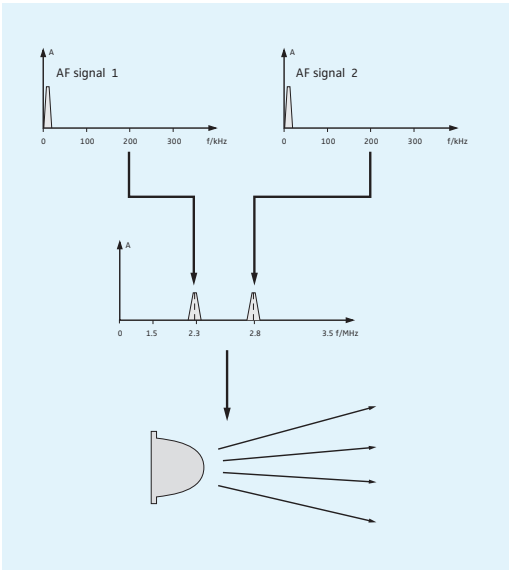


IR transmission signal path



Wideband transmission

Frequencies

The signal path of an infra-red audio transmission involves several frequency ranges:

- The audio information to be transmitted is an **AF signal** (audio frequency signal) with frequencies from 20 to 20,000 Hz when it reaches the modulator.
- The modulator produces an **RF signal** (radio frequency signal) which is used as a "carrier" for the information contained in the AF signal. The frequency of the RF signal is between 55 kHz (lowest narrow-band channel) and 2.8 MHz (highest wideband channel). The use of an RF signal is a prerequisite for reliable transmission in multi-channel systems.
- The information is then radiated as **infra-red light**. For the type of infra-red diodes used in Sennheiser radiators, the frequency is 3.5 x 10^{14} Hz.

Modulation

The process of putting the information of an AF signal onto an RF signal is called **modulation**. The modulation process is explained in more detail in the chapter "Planning Theory".

The specific properties of IR diodes determine the type of modulation used. IR diodes can only radiate light of one colour (and thus one frequency). However, by applying different voltages to the diode, the intensity (i.e. the amplitude) of its light can be varied.

If direct **amplitude modulation** were used, a bass sound of, for example, 100 Hz would make the IR diode light up 100 times per second. This type of modulation has two major disadvantages: First, if several AF signals are mixed for transmission, a receiver will not be able to "reconstruct" the individual signals but will rather take the sum of all AF signals. Secondly, fluorescent lights may lead to interference and disturb the audio signal.

This is why Sennheiser IR technology uses a **combination of amplitude and frequency modulation**. In an intermediate step, the AF signal is transferred to RF bands (channels), with different AF signals being modulated to different channels. These signals are mixed; they control the intensity of the IR diodes. The infra-red signal is then demodulated by the receiver. If several AF signals have been transmitted, the receiver demodulates the signal on the channel to which it has been switched.

Wideband/Narrow-band

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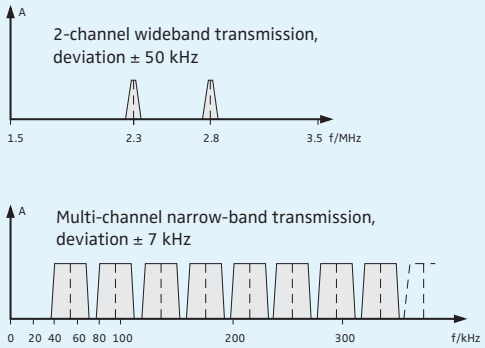

Wideband/narrow-band transmission: modulators and receivers have to use the same principle and operate on matching frequencies!

Channel number	Carrier frequency	Channel number	Carrier frequency
0	55 kHz	16	735 kHz
1	95 kHz	17	755 kHz
2	135 kHz	18	815 kHz
3	175 kHz	19	855 kHz
4	215 kHz	20	895 kHz
5	255 kHz	21	935 kHz
6	295 kHz	22	975 kHz
7	335 kHz	23	1015 kHz
8	375 kHz	24	1055 kHz
9	415 kHz	25	1095 kHz
10	495 kHz	26	1135 kHz
11	535 kHz	27	1175 kHz
12	575 kHz	28	1215 kHz
13	615 kHz	29	1255 kHz
14	655 kHz	30	1295 kHz
15	695 kHz	31	1335 kHz

Wideband/Narrow-band

The RF signal of a channel consists of a **carrier frequency** and frequencies which are slightly above and below this carrier. The band of these higher and lower frequencies is called **deviation**. Rule of thumb: the greater the deviation of the RF signal, the better the sound quality at the end of the transmission path. However, the greater the deviation, the smaller the number of channels which can be allocated in a given frequency band.

Wideband channels allow stereo transmissions with hi-fi quality and an audio frequency response of 20 – 20,000 Hz. Up until recently, only two wideband channels (carrier frequencies 95 and 250 kHz) were approved, but now two more channels can be used for wideband transmissions. The higher carrier frequencies 2.3 MHz and 2.8 MHz show a high immunity to interference for example from fluorescent lights, thus ensuring extremely reliable transmission.

Audio frequencies of 50 to 8,000 Hz can be transmitted on the **32 standardised narrow-band channels** and are suitable for high-quality speech transmission. Compared to wideband systems, the frequency response is reduced, but this is no problem with speech transmissions. Here it is more important to have a larger number of channels, as is for example required in interpreting applications. The table on the left lists the channel numbers and the corresponding carrier frequencies.