

Interference Problems of Fluorescent Lamps Operating on High Frequency Electronic Ballasts with Infrared Remote Control Equipment and Infrared Simultaneous Interpretation System

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1. Introduction

Electronic ballasts (either fixed or dimmable) operating fluorescent lamps at high frequency (from 20 kHz to 100 kHz) have widely been used nowadays in Hong Kong for the purpose of saving energy in lighting. The operating frequency of electronic ballasts should be above 10 kHz in order to obtain 10% more light output, as compared with 50 Hz operation on normal AC mains, and above 20 kHz to avoid the human audibility limit. Apart from these considerations, the factors on interference with other infrared control and communication systems must also be taken into account. Like all lamps, fluorescent lamps emit not only visible light, but also a variable amount of infrared (IR) emission. Modulated in a high frequency, this infrared emission may disturb infrared remote controls as used for television sets, audio and video transmission systems and data communication. This paper will look into ways to avoid such possible interferences.

2. Infrared Radiation

The light we see with our eyes is really a very small portion of what is called the “Electromagnetic Spectrum” (Figure 1). The spectrum includes all types of radiations – from the X-rays used at hospitals, to radio waves used for telecommunication, and even the microwaves we use for cooking.

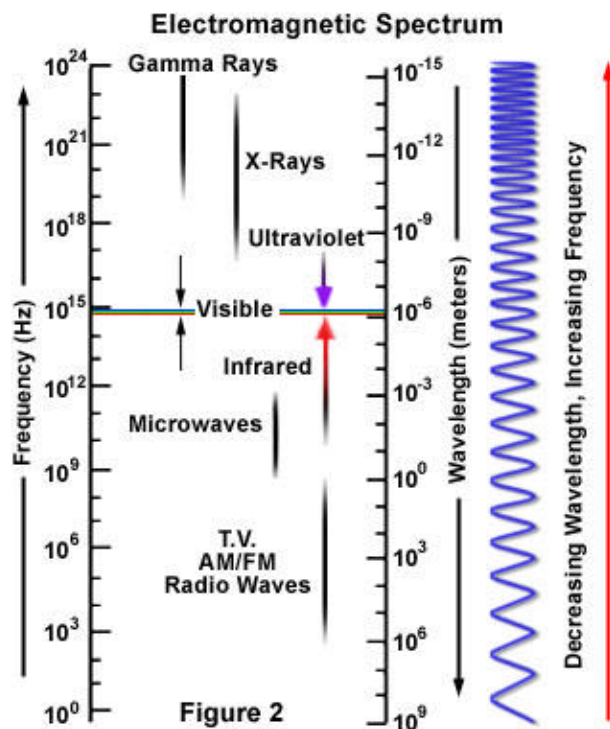


Figure 1 – Electromagnetic Spectrum

Radiation in the electromagnetic spectrum is often categorized by wavelengths. Short wavelength radiations, such as Gamma, X-ray, UV, are of the highest energy and can be dangerous. Longer wavelength radiations, such as radio, microwaves and infrared, are of lower energy and are usually less harmful. Figure 2 shows the visible part of the electromagnetic spectrum (wavelength between 400 nm to 750 nm) and infrared radiation (wavelength between 750 nm to 1 mm) would be located just beyond the red side of the spectrum. Although infrared radiation is not visible, we can sense it as heat from any hot objects.

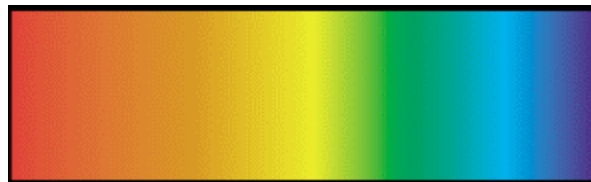


Figure 2 – Visible spectrum

3. IEC Frequency Allocation for Subcarrier

The wireless remote control is a familiar device that uses IR light. Other IR equipment includes wireless headphones, wireless mice and pointing devices for PCs. This IR equipment normally uses IR radiation in the 800 nm to 1000 nm wavelength range, and the brightness of the IR light (intensity modulation) changes when transmitting information. To allow, for example, users to control TV channels with an IR remote control while using a wireless IR headphone at the same time, the specific frequency (subcarrier frequency) that is intensity modulated is allocated for each application. This is a kind of frequency division multiplexing. The allocation of frequencies for consumer products is determined by the International Electrotechnical Commission (IEC). Table 1 shows this IEC subcarrier frequency allocation.

Table 1 – IEC Subcarrier Frequency Allocation

	Types of Consumer Products	Frequency Range Allocated
1	Remote controller	Up to 40 kHz
2	Conference system	40 kHz – 1 MHz
3	High-speed remote controller/data transmission	1 MHz – 2 MHz
4	High-fidelity audio	2 MHz – 6 MHz
5	Analog video	6 MHz – 30 MHz

4. IR Remote Control

For most modern consumer electronic products, from TV sets to room coolers, an infrared remote control is almost always included. The IR remote control system consists of a photoelectric emitter (IR LEDs to generate IR light) and a receiver (which senses the IR light from the emitter).



Figure 3 – IR remote control for VCR

The subcarrier frequency of such infrared signals is typically in the order of around 36 kHz (this is the frequency of the IR subcarrier and should not to be confused with the actual frequency of the IR light itself). The control codes are sent in serial format modulated on the 36 kHz subcarrier frequency (usually by turning the subcarrier on and off).

There are many coding systems in use, and generally different manufacturers use different codes and different data rate for transmission. IR light is invisible as its frequency is below that of visible red.

4.1 IR Emitter and Receiver

In most cases, the IR signals are produced by an LED source in a handheld remote control unit. The IR LED can be tuned “on” and “off” (or modulated) at a high rate of speed, typically at a frequency of several kHz.

Phototransistors are mostly used inside the consumer electronics as signal receiving devices. This modulating of the IR emission from the LED means that the amplifier of the phototransistor receiver can be “tuned” to the frequency of modulation, and amplify only light signals pulsing at that frequency. It is important to note that a receiver should ignore ambient light and responds to only to its modulated light source. However, extremely bright ambient light sources may sometimes present problems. No photoelectric receiver will function normally if it is pointed directly into the strong IR sources, such as sunlight. This is called “ambient light saturation”. Figure 4 shows an operation diagram of a IR remote control system and Figure 5 highlights how remote control signal is received and amplified to carry out the required control function.

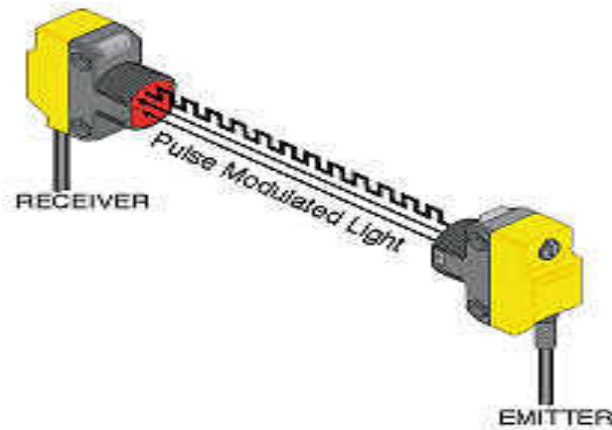


Figure 4 – Remote control system using modulated IR

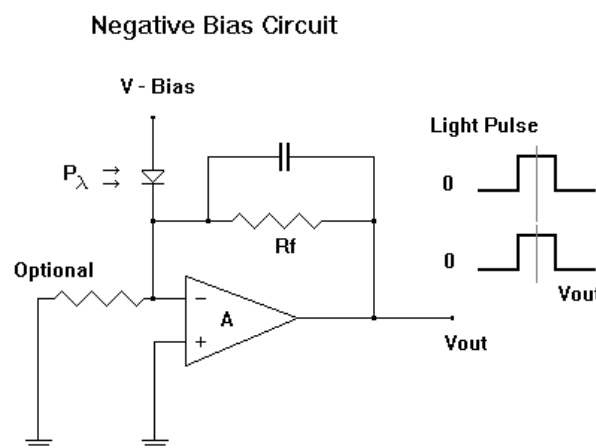


Figure 5 – Negative bias circuit of a IR remote control

The lowest practical frequency for IR remote control systems is found to be 36 kHz. The operating frequency of electronic ballasts for fluorescent lamps should therefore not be 18 or 36 kHz. Nowadays the frequency range from 30 to 40 kHz is more or less reserved for IR remote control systems. The operating frequency of electronic ballasts should therefore be designed to avoid, normally higher than, such frequency range.

5. IR Simultaneous Interpretation System

The Simultaneously Interpretation (SI) systems used in Hong Kong are mostly IR systems operating in the frequency ranged from 40 kHz to 1 MHz (IEC subcarrier frequency allocated for conference system). A SI system is almost indispensable for meetings and conferences where multiple languages are used. In order to enable all participants to understand the proceedings, interpreters simultaneously translate the speaker's language as required. These interpretations are then distributed throughout the meeting venue and delegates and audience can select the languages of their choices and listen to it through headphones.

In simple term, an IR distribution system consists of a transmitter, one or more radiators and a number of receivers. Figure 6 shows a typical layout of an IR SI system used in Hong Kong. The heart of the system is the transmitter, which generates a subcarrier wave for each channel. Each interpretation language supplied

by the audio source is frequency-modulated on one of these subcarriers. All the modulated subcarriers waves are mixed, and then fed through a coaxial cable from the transmitter to a series of IR radiators.

The output of the IR radiators (Figure 8) is modulated IR light. Each audience is supplied with a pocket receiver, which has a convex lens to collect the IR signals and direct them to an IR sensitive phototransistor. The receiver decodes the incoming signals and the audience selects one of these signals (i.e. the required language) with a channel selector. The selected signal then passes to the audience's headphones.

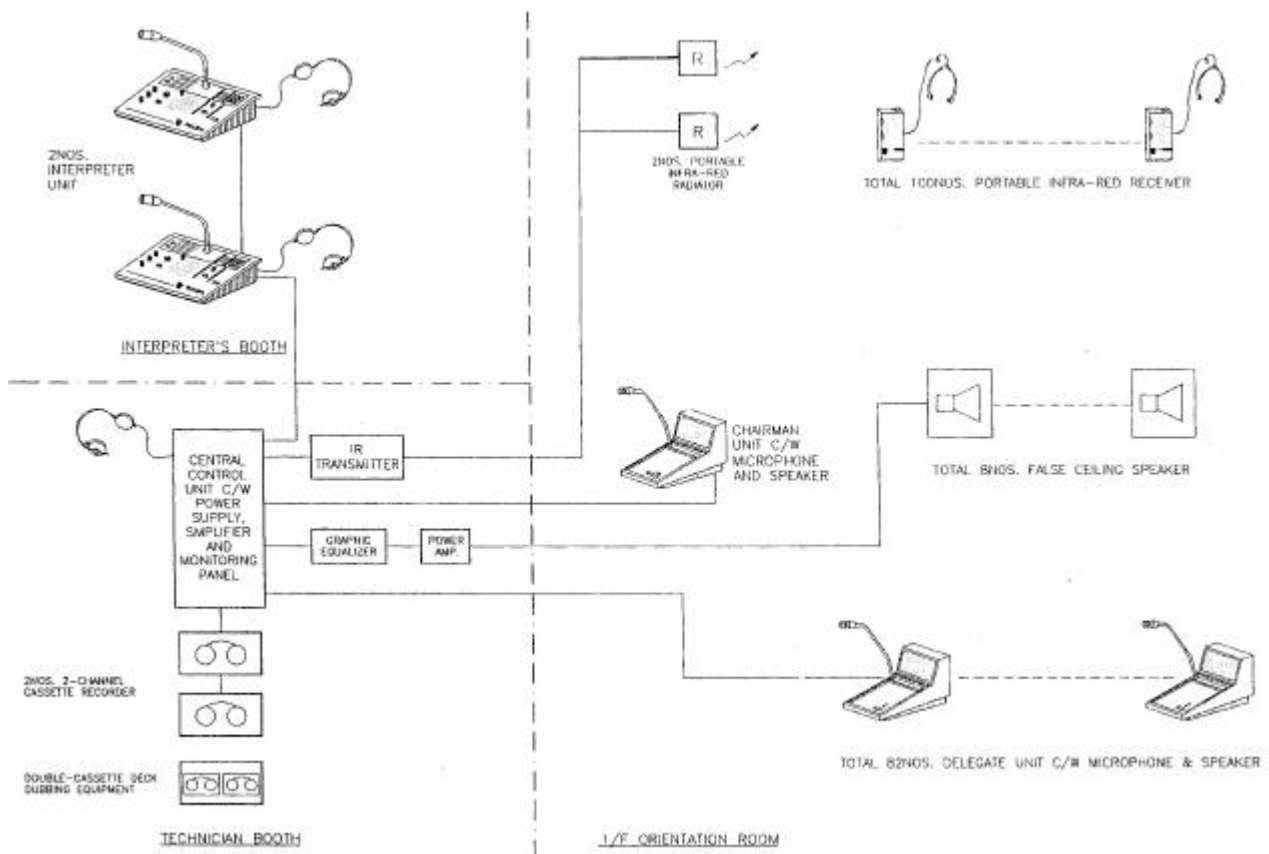


Figure 6 – A typical configuration of an IR SI system used in Hong Kong



Figure 7 – A typical IR radiator used for SI system in a lecture hall

5.1 Characteristics of IR SI System

IR radiation is an ideal medium for audio distribution. It is invisible to human eyes and can carry multiple channels with a separate language each. IR radiation can travel relatively long distance but is unable to pass through opaque structures such as wall, door, etc. Unlike transmission using radio frequency, this non-penetration property of IR avoids sound escape and provides good conference privacy against being overheard and tapped outside the meeting room. In venue with multi meeting rooms, there is no cross-talk between one hall and the other, and therefore no interference between separate conferences. Typical IR distribution system has a maximum of 16 channels and can therefore be distribute up to 16 languages.



Figure 8 – A typical IR SI installation in a conference room

5.2 Effect of Ambient Light to IR SI System

There are a number of situations where ambient light affects the audio quality of an IR audio distribution system. They are sunlight, incandescent lamps and fluorescent lamps operating on conventional electromagnetic and high frequency electronic ballasts.

If sunlight falls directly on an IR receiver, the phototransistor will be saturated and considerable amount of noise are generated and this should therefore be avoided. For venues containing large windows, screening must be used to prevent sunlight falling directly on receivers or alternatively, additional radiators must be added.

Incandescent light sources such as tungsten filament lamps and halogen lamps, with and without a dimming facility, emit a high level of IR radiation and will add considerable amount of noise. It may be necessary to install additional radiators to compensate.

Tubular fluorescent lamps emit a small amount of IR radiation (See Figure 9 for spectral distribution of different ambient light sources). When they are operating on conventional electromagnetic ballasts, the emitted IR is modulated with the mains supply frequency of 50 Hz and does not present major problems in the IR SI system.

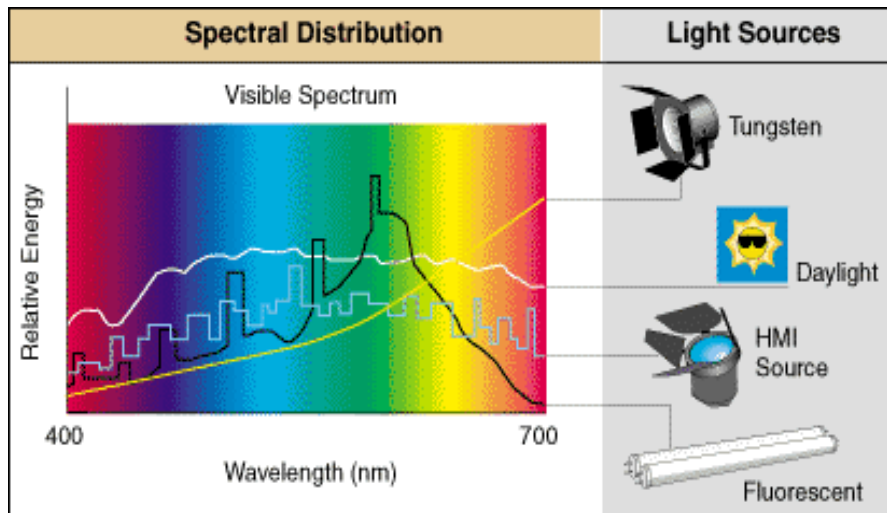


Figure 9 – Spectral distribution of some ambient light sources

5.3 Effect of Electronic Ballast Operated Fluorescent Lamps to IR SI System

Most fixed output electronic ballasts (Figure 11) nowadays work at a frequency of about 40 kHz. Fluorescent lamps operating at this HF emit a certain amount of IR modulated at 40 kHz and may cause interference at up to 280 kHz (i.e. 7th harmonics). This interference can be overcome by using the up-shift facility of the SI system to avoid channels operating below 280 kHz.

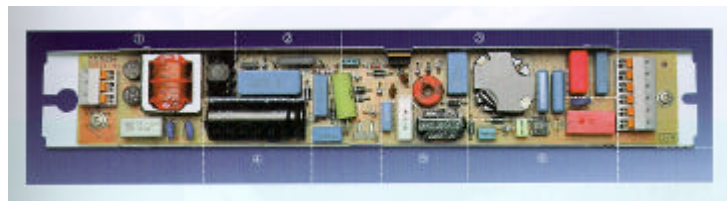


Figure 10 – A typical electronic ballast operating at 40kHz

However, in most sophisticated conference rooms, light dimming facilities using dimmable HF electronic ballasts are very common for various scenes control. Dimmable electronic ballasts operating fluorescent lamps between 40 kHz (under maximum light output conditions) to 100 kHz (under minimum light output conditions) might introduce interference to IR receiver up to 400 kHz. Special precautions must be observed in using the conventional analogue IR SI system. In general, it is advisable to carry out a site test when there is not enough information about the lighting and SI systems.

5.4 New IR Digital Audio Transmission SI System

With the advance of digital technology in digital audio transmission (DAT) system, the possible interference problems of the analogue IR SI system with electronic ballasts could be avoided. The DAT system uses the 3 MHz to 6 MHz carrier frequency band, which falls into the allocation for high-fidelity audio range. Typical example of the new digital system is “Philips” Digital Congress Network (DCN). Design engineers of the IR SI system are strongly recommended to design the system using the new DAT technology for better audio quality and interference-free IR

transmission disregarding the effect of the fluorescent lighting system installed in the same venue.

6. Conclusions

Based on the discussions and observations above, the following conclusions are highlighted:

1. As far as energy saving is concerned, the use of electronic ballasts for operating fluorescent lamps is irrevocable in Hong Kong. Besides, the new generation of T5 fluorescent lamps, which is becoming the most popular energy efficient light source, is designed for operation by HF electronic ballasts only.
2. The interference problems between HF electronic ballast operating fluorescent lamps and IR remote control equipment could be avoided by specifying the operating frequency of electronic ballasts to be above 40 kHz.
3. Strong and intensive incandescent light sources, such as tungsten filament lamps and tungsten halogen lamps, should not be used in conference room equipped with IR SI system because of their possible interference with the receivers of the IR SI system.
4. Intelligent digital lighting control systems utilizing dimmable electronic ballasts are normally designed in conference rooms for scenes setting to suit various functions. It is advisable for SI system designer to employ the new generation of digital IR audio transmission system rather than the conventional analogue IR SI system for better sound quality and elimination of interference problems with fluorescent lamps operating on HF electronic ballasts and other IR sources.
5. It is strongly recommended that engineers designing the lighting and other BS systems of a conference room to collaborate with the SI engineer at the early stage of a project to form an integrated conference facility system to eliminate any possible coordination and interference problems. A joint site test is also advisable before different kinds of services equipment are installed on site.