CS55 general guidelines

The following is a technical background document for the CS55 family of products.

The document's purpose is to provide the answers to common questions that may arise during the purchase decision, and during installation and use of the CS55 wireless headset adapter. This document may be provided to customers who have technical questions. For specific installation and troubleshooting information please refer to the CS55 Quick Start User Guide, and to the Product Information Booklet. Further assistance may be obtained from the Plantronics Technical Assistance Center at (800) 544-4660 in the US or at (800) 540-8363 in Canada.

The CS55 is a system consisting of an integrated wireless headset and a base unit. The CS55 is designed to connect to a telephone in place of the telephone's standard handset. The base unit and the headset communicate using secure radio communications. Various accessories are available including a mechanical lifter/ring-detector and an on-line indicator. The headset can be used over-the-head or over-the-ear, and an optional behind-the-head headband is available.

The technology

Radio system

The CS55 operates in the 1920 – 1930 MHz (1.9 GHz) UPCS radio band. UPCS refers to the Unlicensed Personal Communications Services band designation used in the USA. The equivalent designation in Canada is LE-PCS, for License-Exempt Personal Communications Service.

The voice transmission method used is digitization, 32kbit/s ADPCM vocoding, encryption of the vocoded data, then formatting into TDMA format and PSK modulation. The transmitter operates at a low duty cycle in non-constant-envelope mode. The CS55 communications protocol is based on the European DECT standard, slightly modified to comply with the regulatory requirements for the UPCS spectral etiquette, and for operating in the 1920 – 1930 MHz band instead of the 1880 – 1900 MHz band specified for Europe and countries sharing frequency bands with the European allocations.

Certification and type-acceptance

The CS55 is certified according to the requirements of 47 CFR Ch. 1 ss 15D for UPCS systems, the regulations established by the Federal Communications Commission of the United States. This product (when so marked with an IC registration number) is also certified according to the regulations of Canada according to the requirements of RSS-213 Issue 2. Inquiry should be made directly to Plantronics through the Technical Assistance Center concerning the use of the CS55 product in other nations.

Transmit levels

Transmitter signal level (transmitter output power) is 10mW peak and 0.4mW average. Measured maximum SAR level is 0.0056 W/kg. The CS55 transmitter is a low-power transmitter. For comparison, the CS55 average transmitter signal level is about 1/1000th of the maximum transmit signal level used by cellular phones.

Electromagnetic Compatibility

The CS55 uses a TDMA/TDD transmission system. This transmission system turns the transmitter on periodically and at a low duty cycle to send voice data packets. This is similar to some modern cellular telephone systems, though at much lower transmit power. The low transmit power level generally permits operation of the CS55 in all environments, the exception being within a few feet of EKG, EEG, pulse oximetry, or similarly sensitive equipment. The general rule about electromagnetic compatibility for the CS55 is that units can be used wherever cellular phones can be used, and will be less of an electromagnetic compatibility challenge than a cellular phone because of the CS55's very much lower transmit signal level.

Security and unique identity

CS55 compliance with privacy and confidentiality regulations

The CS55 is HIPAA compliant and Sarbanes-Oxley (2002) sec. 404 compliant. This statement is based on the compliance of the encryption measures incorporated in the product with the requirements of USA regulation 45 CFR 164.312(a)(2)(iv).

Voice privacy
The CS55 provides excellent security against eavesdropping. The casual eavesdropper listening to the radio channel will hear only a buzzing sound since the audio is digitally coded and encrypted. The CS55 avoids two users sharing the same channel and timeslot under normal circumstances because units automatically chose the best available channel, and will change channels automatically if the channel in use experiences interference from another user. In the event of operation in a high-density system where no other better channel and timeslot is available, two users near each other and sharing the same channel and timeslot will experience occasional mutes of the receive or transmit audio and occasional audio distortion artifacts, rather than intercepted audio.

The protection against deliberate eavesdropping is through user authentication and 64-bit true digital encryption of voice data according to the standard algorithm of EN 300 175-7. A description of the public portion of this encryption algorithm is available through the website of the European Telecommunications Standards Institute (ETSI) at www.etsi.org. Individuals and organizations having a credentialed need for more detail regarding the encryption scheme should contact Plantronics Engineering through the Technical Assistance Center. The CS55 in particular and the DECT standard in general are considered secure enough for commercial applications requiring voice privacy. This assurance is based on the 64-bit digital encryption of speech and the internationally-recognized and standardized encryption algorithm used.

The CS55 uses fixed-rate adaptive frequency hopping during idle-locked state, which is when the base and the remote are in range but audio is not enabled. This was done to ensure that the base and remote are compensating for changes in the radio signal spectrum due to other users and the presence of interferers, and thus to improve the reliability of the link, but it has the effect of adding a layer of security. The hop sequence is random, on the basis of the physical environment. The CS55 uses aperiodic adaptive frequency hopping when an audio link is enabled, for the same reason. The system is aperiodic because in this mode rather than changing channels at a fixed interval of time, the system hops channels whenever there is another user sharing the same channel and producing interference. In an environment with many users, this adds a layer of security because users change channels from time to time, rather than staying in a fixed channel. This adaptive approach offers improved security relative to other systems which use a single, common and fixed hop sequence for frequency hopping.

Understanding pairing of CS55 base and headset units
The CS55 headsets and bases are paired uniquely. The communications protocol permits audio exchange only between a headset and a base that are paired. The user can subscribe a new headset to an existing base to create a new pairing, or an existing headset can be subscribed to a new base, but a base can be paired with only one headset at a time, and a headset can be paired with only one base at a time. When a new pairing is established, the old pairing is lost.

Each base and headset unit has a unique identity. A headset will link only to a base that has the identity that the headset is expecting, and a base will link only to a headset that has the identity that the base is expecting. The process of initially pairing a base and a headset to create the expected identifiers in each end of the link is called subscription. A CS55 base and a CS55 headset can each be subscribed to only one headset or base, respectively. If a new headset is subscribed to a base, the old headset is automatically unsubscribed, whether it is in the area or not.

If a second headset is subscribed to a base that is already subscribed to a first headset using the process described in the CS55 Product Information Booklet, the first headset will commence flashing its Talk LED about three times per second continuously, to indicate loss of subscription, and the establishment of a clear audio link through that headset will no longer be possible. See the directions in the CS55 Product Information Booklet to perform re-subscription, in the event of a lost subscription.

Battery system

The battery used in the headset is a single Lithium-polymer cell. It offers all-day (10 hours) talk time on a three-hour charge, and half-day talk time on a 1-hour charge. The battery and charger system are designed to resist wearout of the battery; for many users, the battery will last the life of the product. The battery does not exhibit memory effect; best battery life is obtained by keeping the headset docked on the base when not in use.

The headset may run the battery down in a few days when the headset is out of range of the base unit. If the headset has a fully discharged battery, it must be docked for at least a few minutes to charge before use; one hour docking is recommended prior to use if the battery is completely discharged.

Battery state indications

1) Fully discharged - pressing the Talk button on the headset results in no response in the headset; no beeps from the earpiece, and no activity on the Talk indicator LED on the headset. Docking the headset in this state is necessary to charge it. The system will not subscribe or enter Talk mode for several minutes, until the battery charges somewhat.

2) Nearly discharged - pressing the Talk button on the headset results in the error tone (three beeps in the headset earpiece) and the unit does not enter Talk mode. A background beep (lower frequency) every 10 seconds is present, indicating that the battery is low. The system may not subscribe, or the system may subscribe if the headset is docked but may still not enter Talk mode, or the system may subscribe and enter Talk mode when docked but may not link after the headset is undocked, or the system may link but then go unlinked a few minutes after undocking.

3) Normal - pressing the Talk button causes the system to enter the Talk mode. The system can be subscribed docked or undocked, and will link undocked or docked.

The headset battery will charge enough in a few minutes of docked charging to operate normally, at least for a few minutes.

Charger state indications

1) When the charger in the base is charging the headset, the amber charge LED on the face of the CS55 flashes once per second. This charging takes about three hours to complete, for a completely discharged battery.

2) After the charger has completed charging the battery, the amber LED switches from flashing to continuously on.

3) If there is a fault in the battery, or the headset is not seated properly when docked, the amber charge LED will flash at a rapid rate. Try redocking the headset; if the problem continues then the battery needs to be replaced.

Audio performance

The headset incorporates a noise-canceling microphone optimally positioned for best speech fidelity, and a dynamic speaker. The audio processing is 32k ADPCM, telephony bandwidth. Listen volume adjustment is provided in the headset, with larger (centering) listen volume adjustment possible using the 1234 volume switch on the back of the base. Talk volume is adjusted using the up/down arrow buttons on the back of the base. Larger (centering) talk volume adjustment is possible using the ABCD switch on the underside of the base. Speech transmissions may be fully muted using the Mute control on the headset.

The CS55 is offered in both long-boom (CS55) and short-boom (CS55 Micro) versions. The short-boom version offers the convenience of a compact form factor, but has a more sensitive microphone, as the microphone port is farther from the user's mouth. This sensitive microphone tends to pick up background noise. Accordingly, the CS55 Micro is best suited for use in quiet areas; use of the CS55 Micro in areas where background noise is present often results in unacceptable transmit audio quality. The CS55 is recommended for areas where the level of background noise is too large for acceptable transmit audio quality for the use of a CS55 Micro.

Interference

The CS55 operates in the 1920 – 1930 MHz (1.9 GHz) UPCS band; all equipment approved for this band must implement a spectrum-sharing etiquette that minimizes mutual interference. The CS55 does not generally suffer interference from systems that use other bands; it is compatible with Bluetooth, most LANs, and with 802.11a, 802.11b and 802.11g systems under normal circumstances.

If the base or headset are placed within a few inches of a cellular phone, the CS55 system may experience interference. Reposition the cellular phone or the base or headset to increase the separation if this problem occurs.

Sidetone level

For some installations the user may hear distorted sidetone. They hear their own speaking voice in the CS55 headset as they speak, and the audio sounds harsh or rattley. This usually occurs if the talk volume level is too high, or if there is a telephone compatibility adjustment that is not correct. If distorted sidetone occurs, the user should adjust the headset's listen (receive) volume level to nominal (where the "centered" beep is heard as the receive volume adjustment in the headset is adjusted up or down), and should adjust the telephone's listen volume to be centered. Then adjust the talk volume level downward using the Speak Volume Fine Tune up/down buttons on the back of the base until the distortion in the sidetone disappears. If the talk volume adjustment is already at or near the low end of the adjust range, change the Speak Volume Master slide-switch on the bottom of the base to the next lower letter; from D to C, C to B, or B to A, and adjust the Speak Volume Fine Tune up/down buttons for somewhat reduced talk level relative to the original loudness. Be aware that not all Telephone Configuration Dial tumbler positions will work with all Speak Volume Master slide-switch positions. For example, tumbler position 1 may work with slide position B but not with slide position C. Most systems for which distorted sidetone is a problem will perform properly with one to three steps of reduced transmit volume, adjusting the Speak Volume Fine Tune up/down buttons on the back of the base. After setting the talk audio level, readjust the headset listen (receive) volume to a comfortable level.

If distorted sidetone persists with reducing the talk (transmit) audio level, try changing the Telephone Configuration Dial tumbler setting to another position. Often several positions will appear to work but audio will be distorted in one of the positions.

Range and user-density

Range is as much as 100 feet, for an installation with only a few CS55s in place. The effective limit to range is set by audio artifacts introduced by the weak signal. The system reduces the volume level when operating near the edge of range, to improve subjective audio quality. Range can be reduced within a building by the obstruction of interior walls, or by the presence of other systems using the UPCS (1.9 GHz) band, or by the presence of a large number of other CS55 users in the immediate area.

Guidelines on planning a density site

The CS55 can be used in a high-density application within certain limitations, if there are barriers such as cubicle walls preventing line-of-sight between individual users while in talk mode. The system automatically senses the presence of other users and will reduce coverage area if there are too many other users to permit good audio performance at long range. In a high-density environment the system becomes a short-range in-office system. The level of density at which this effect begins to occur depends on how much time all users in an area spend with their systems in talk mode, and how far away the users are from each other. The general rule to follow is that in an office layout with cubicle walls high enough to prevent line-of-sight when users are seated, if there are more than 30 users talking at the same time and within 100 feet of each other, the system will be in-cubicle only, and if there are fewer than 15 users within 100 feet, or with less than full-time usage, then the coverage area will be larger. In a density-limited environment coverage may be limited by loss of audio (random muting), or by audio distortion artifacts increasing as the user walks away from the base. The worst-case for this coverage limit will occur when a user is distant from their own base but close to other user bases or headsets.

In a high-density application the headset may take some time to reestablish connectivity with the base when the user returns to the coverage area after having been out of range. It normally takes a few seconds for the headset to find the base's signal as the user enters the coverage area, but this process can take a minute or so in a high-density application. To the user this effect appears as inability to enter talk mode until the user has been in the coverage area for a minute or so.

In most environments, even for high-density, users in a cubicle grid with walls high enough to prevent line-of-sight with other users while the system is in use will probably get clear audio within their own cubicle. Users will both receive and be a source of interference if they leave their work area while a call is in progress. For the users in a higher-density application, a dense open floorplan without cubicle walls, acceptable audio quality may not be achieved if there are more than 30 users within view. Achievable density for all installations is dependent on the building layout, and on other environmental factors. Experience with such products has taught that often performance in a high-density application is satisfactory even for very large numbers of users, several hundred on a building floor, as long as there is sufficient physical separation of the radio signals from different users. This separation can be attained by cubicle walls, by hardwalls, or in some cases by physical distance. An open-plan layout (no cubicle walls or hardwalls) with more than about 30 users of CS55 units within line of sight of each other will, however, probably not offer acceptable audio quality for most users even at short range from base to headset.

In high-density applications it is important not to have other UPCS or 1.9 GHz DECT products in use in the area. Even though such systems are required by the conditions of regulatory approval for the UPCS band to automatically choose channels of operation in such a way as to minimize mutual interference, interference ultimately limits density. Interference may come from systems well outside the coverage area, as the range for interference is greater than the coverage range.

CS55 over/underlay systems for simultaneous density and roaming

The CS55 operates in a different radio band than does the CS50, the CS50 and CS55 products each do not mutually interfere with products of the other type, and so adding CS50s to a CS55 installed base, or vice versa, does not degrade performance. This can allow a high-density CS50 installation to coexist physically in the same area as a high-density CS55 system, offering a net greater density, or it can allow a low-density CS50 or CS55 system to coexist physically with a high-density system of the opposite type. If a customer desires to have both long-range and high density service within an area, the mass of employees can be offered CS55 units, and a few CS50 units can be installed for supervisory employees or those with unique roaming requirements. As long as the number of CS50 units within a geographic area is limited, the CS50 users can roam. The CS55 users, with a unit on every desk (for example) are

limited in roaming range, but the CS50 users are not so constrained. A typical such installation in a cubicle environment would have a CS55 on every desk offering performance as noted previously in the discussion of high-density installations, while up to 30 users of CS50 systems could be present in the "long range area", each roaming to the full range offered a CS50 system in a low-density application, limited only by the signal strength loss with distance rather than by interference from other users. For such a system, the high-density installation portion should be CS55-based, and the long-range portion should be CS50-based, as the CS50 has a longer native range.

A caveat:
Accurately predicting the effective range and region of susceptibility to interference for individual environments and building layouts is of sufficient complexity as to be beyond the scope of this discussion. The preceding information is provided as a reference for system planning, and the performance of individual installations may vary.