Bar Code Scanning in a Patient Care Environment

The Safety of Laser Bar Code Scanning in Patient Care Applications

August 2005

Because of recent attention on the deadly impact of medication errors, there has been increased pressure to implement more accurate pharmaceutical inventory controls and automatic identification technologies to reduce or eliminate these errors. Particular attention has been directed to the administration of medication to hospital patients by medical staff and the use of computer and automatic identification (Auto ID) technology to ensure compliance to what are known as "The Five Rights" – The right patient, the right time, the right medication, the right strength and the right dosage.

In considering the Auto ID technologies available for this application, bar codes are the most common as well as the most easily and economically implemented technology today. Bar codes placed on patient identification bracelets and medicine labels are scanned into a computer to verify accuracy before any medication is administered. Using bar code scanning technology, a hospital can identify and prevent thousands of potential errors each year, saving lives.

Among the technologies available for reading bar codes, laser scanning has several significant advantages over other methods. These advantages include a faster read rate, lower power requirements (which result in longer battery life for portable terminals) and less user training needed, because laser scanners are typically more intuitive to use than other technologies.

Questions have been raised, however, about the safety of using laser bar code scanners in close proximity to patients, with particular concern about potential damage to the patient's eyes. This technology brief addresses the issue of laser safety in the patient care environment.

Laser Applications

The use of lasers in everyday life has become so common that most people don't give much thought about safety issues. From laser light shows and presentation laser pointers to range finders and laser levelers for construction and household uses, lasers are being used in a growing number of everyday applications. By far the most common use of lasers today is in CD and DVD players. Heavier duty lasers are used as surgical tools, in space-age weapons and for the precision cutting of steel plates, so it's obvious that some lasers can be extremely dangerous to humans.

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Laser Classifications

Lasers used for commercial purposes (non-military) are categorized into six classes and sub-classes, according to the power and radiation frequency of the laser. In the United States, these classes are defined by the federal Food & Drug Administration and documented in the Code of Federal Regulations, in a section entitled *Performance Standards for Light-Emitting Products*. Please refer to Appendix A to view pertinent excerpts from this document, as well as a link to the entire document in the US government archives.

Lasers in Bar Code Scanners

Bar code scanning became much faster and could be done from greater distances with the introduction of laser scanning technology.

The first bar code scanners were wand-type contact scanners that used very low power red LEDs. As the scanner was swept across a bar code like a pencil, light from the LEDs was focused through a lens in the scanning tip. Later, bar code scanning became much faster and could be done from greater distances with the introduction of laser scanning technology, which used mirrors to manipulate concentrated light beams into laser scanning patterns. The most common laser scanning pattern is the omni-directional pattern, produced by plate scanners such as those found in most grocery store checkout counters. In this device, a crisscross pattern of 6 to 12 scan lines is created from a single laser beam using a precise assembly of both fixed and spinning mirrors. Omni-directional scanners are very effective if the bar codes to be read (a) are to be presented to the reader (i.e., the scanner is kept stationary); and (b) the orientation of the presented bar code is random.

Another very common laser scanning pattern is a single line created by a mirror that swings the reflected laser beam back and forth across an arc of from 30 to 60 degrees at speeds from 35 to over 200 sweeps per second. This single line pattern is most commonly used in handheld gun-type scanning devices, which are very effective when (a) the reader is moved to the bar code; and (b) the scanner can be easily aligned so that the scanning line passes across the bar code.

In most patient care applications, the single line laser scanning pattern is best because the need to reposition patients while scanning identification bracelets is minimized. All of Socket's laser-based bar code scanners use this scanning pattern.

Laser bar code scanners of all types have traditionally used lasers rated as Class 2 by the FDA.[1] These lasers have a maximum laser power output of 1.2 mW (milliwatts). Class 2 lasers, often called "low-power" or "low risk" laser systems, are safe to use and can only cause eye injury if you stare into the laser beam for an extended period of time. A safety education bulletin published by the Laser Institute of America explains:

[1] Although Roman numerals are used in official government documents to describe laser classes, the Auto ID industry has traditionally used the Arabic equivalents.

***Momentary viewing is not considered hazardous** since the upper radiant power limit on this type of device is less than the Maximum Permissible Exposure for momentary exposure of 0.25 second or less. **Intentional extended viewing, however, is considered hazardous**.*[2]

Eye injury is extremely unlikely, not only because of our natural "Human Aversion Response," but also because the beam of a Class 2 laser moves rapidly back and forth, making it virtually impossible to stare into it continuously.

One quarter of a second (0.25) is the time it takes to trigger the natural "Human Aversion Response" — blinking or turning away after a bright glare enters the eye. Class 2 lasers can cause eye injury only if you resist your natural inclination to blink or turn away and intentionally stare into the laser beam. Such an event is extremely unlikely, not only because of our natural "Human Aversion Response," but also because the beam of a Class 2 laser moves rapidly back and forth, making it virtually impossible to stare into it continuously.

In omni-directional scanners, this safety factor is so effective that the FDA allows the scanners to be placed where either a checkout clerk or a shopper could easily hold their face in the scan pattern and look directly into the laser light. The laser line pattern of gun scanners is not quite as safe, as the light is concentrated in a single line rather than multiple lines, and although not typical of its "intended use," the gun can be deliberately or unintentionally pointed at someone by the user. Even so, a person would still have to resist their natural Human Aversion Response in order to suffer eye damage.

Class 1 lasers are considered incapable of providing damaging levels of laser emissions.

In response to laser safety concerns voiced by specific parties (primarily German labor unions), a few bar code laser scanners are available with Class 1 lasers, which have a maximum power output of only 0.5 mW, less than half the power of Class 2 lasers. These lower power scanners, while typically not able to scan at distances greater than 24 inches or in direct outdoor sunlight, are entirely suitable for most normal indoor bar code scanning applications. The *Technical Manual* published by the U.S. Occupational Safety and Health Administration describes Class 1 lasers as "the least-hazardous class," "considered incapable of providing damaging levels of laser emissions."[3]

All Socket bar code scanning products based on laser technology are available with either Class 1 or Class 2 lasers.

Other Scanning Technologies

The ability to read bar codes with either CMOS or CCD digital imaging technologies has been available for several years. Digital imaging has proven to be the only way to decode true two-dimensional (also known as Matrix) bar codes such as Maxicode, DataMatrix, Aztec or QR Code. In the last few years, advances in imaging technology have reduced the size and expense and increased the effectiveness of scanning capabilities to the point that image-based scanners are comparable to laser-based systems.

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[2] Laser Institute of America. *Laser Safety Information Bulletin*. www.laserinstitute.org/publications/safety_bulletin/laser_safety_info/

[3] U.S. Department of Labor Occupational Safety & Health Administration. OSHA Technical Manual. Section VI: Chapter 1, Hospital Investigations: Health Hazards. www.osha.gov/dts/osta/otm/otm_vi/otm_vi_1.html

Image scanners typically consume much more electrical energy than laser scanners. The main reason for this is the large amount of auxiliary lighting required to capture a clear, high resolution image of the target bar code. This auxiliary lighting, typically provided by an array of multiple LED's, is not as concentrated as a laser, but is extremely bright and can cause temporary visual discomfort if viewed directly even for a very short period of time.

Some people with epilepsy or who suffer from migraines are susceptible to blinking lights, and the bright, blinking lights from an image scanner, even if not viewed directly, may possibly induce an epileptic seizure or a migraine.

Another potential problem is that, to conserve power, many of the LED's blink on and off in a frequency that varies according to the available ambient lighting and imager frame rates. Some people with epilepsy or who suffer from migraine headaches are susceptible to blinking lights, and there is a slight possibility that the bright, blinking lights from an image scanner, even if not viewed directly, may induce an epileptic seizure or a migraine. Consequently, image scanners may not be the safest bar code scanning solution in the patient care environment.

Some devices known as 'area' image scanners use Class 2 lasers to define the area to be captured by the imager. These "aiming" lasers typically highlight the four corners and the center of the area to be captured in an image, and usually shine a steady, bright light for the three or more seconds allowed to capture an image and decode the bar code. This subtler use of a Class 2 laser in an image scanner may present as much or more of a hazard to nearby patients than a single line laser scanner because the user, thinking that an image scanner is safe, may fail realize the potential (though unlikely) laser danger.

Conclusion

Class 1 lasers, Class 2 lasers and image-based scanners are about equal in their ability to scan linear bar codes in a hospital setting. Both Class 2 lasers and image-based scanners present some level of potential danger to patients when used in a patient care environment, leaving bar code scanners based on Class 1 lasers to be the absolute safest.

Throughout its laser safety documentation, the FDA repeatedly uses a key phrase — "when used for their intended purpose" — to describe safe laser usage. It is an obligation of any company using portable bar code scanning equipment of any type to educate end users that any type of bar code scanner should be used carefully and with the understanding that the device should never be aimed at another person's face, either intentionally or unintentionally. Doing so will not likely cause permanent vision damage, but can certainly cause patient anxiety and discomfort because of the perception that it might.

In any case, the potential danger from medication errors to hospital patients is much higher than that posed by any bar code scanning technology used to reduce or eliminate those errors. Eye injuries from Class 1 or Class 2 lasers are extremely rare, but thousands of Americans die from medication-related errors each year.

Frequently Asked Questions

Q: What are one dimensional (linear) and two dimensional (matrix) bar codes? Which are used most in the health care industry?

A: One-dimensional (linear) bar codes are the bar codes most people are familiar with, consisting of patterns of bars and spaces, and capable of holding about 10 to 20 ASCII characters. There are two types of two-dimensional (2D) bar code symbologies: Stacked and Matrix. Stacked symbologies such as PDF417, MicroPDF and RSS Composite are made up of stacked linear codes, while Matrix symbologies such as Maxi Code, Datamatrix, QR Code and Aztec use a matrix of small geometric shapes to represent data. While a linear bar code only requires the scanner to read a single narrow band across the bar code, a 2D bar code requires the scanner to read the code both horizontally and vertically (two dimensions). Laser scanners are able to scan linear and most stacked bar codes, but only an image scanner can read matrix bar codes.

Currently, one-dimensional bar codes are the primary type being used in health care. Usage of two-dimensional bar codes is on the rise, especially RSS14 bar codes for storing information on small unit-dose medication packages.

Q: What are CMOS and CCD digital imaging technologies?

A: CMOS (Complementary Metal Oxide Semiconductor) and CCD (Charged Coupled Device) are light sensor technologies that can sense light patterns and convert them into digital information. Besides bar code scanners, they are found in digital cameras.

Q: In addition to the reduction of medication errors, what other benefits are there in implementing bar code scanning technology in a patient care setting?

A: The use of bar coding (or any Automatic ID technology) in a patient care setting also reduces nurses' apprehension about medication errors, reduces their administrative burden, and promotes accurate documentation. Overall time spent on documentation tasks is reduced.

To read how St. Clair Hospital, Pittsburgh benefited from the use of bar codes, please visit: www.socketcom.com/about/press/read.asp?ID=161

Q: Where can I find information about bar code scanning applications for the health care industry?

A: Visit Socket's vertical solutions webpage for health care at: www.socketcom.com/solutions/industry.asp?Type=Vertical&VerticalMarket=Health%20Care

Appendix A: Laser Classifications

The following excerpts are from the Food and Drug Administration document, *Performance Standards for Light-Emitting Products* (Title 21, Chapter I, Subchapter J, Part 1040). The entire document can be found online at: www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?FR=1040.10

Please note that that Tables I, IV, and V are provided on pages 10-12.

b) *Definitions.* As used in this section and § 1040.11, the following definitions apply:

(1) *Accessible emission level* means the magnitude of accessible laser or collateral radiation of a specific wavelength and emission duration at a particular point as measured according to paragraph (e) of this section. Accessible laser or collateral radiation is radiation to which human access is possible, as defined in paragraphs (b) (12), (15), and (22) of this section.

(2) *Accessible emission limit* means the maximum accessible emission level permitted within a particular class as set forth in paragraphs (c), (d), and (e) of this section.

(3) *Aperture* means any opening in the protective housing or other enclosure of a laser product through which laser or collateral radiation is emitted, thereby allowing human access to such radiation.

(4) *Aperture stop* means an opening serving to limit the size and to define the shape of the area over which radiation is measured.

(5) *Class I laser product* means any laser product that does not permit access during the operation to levels of laser radiation in excess of the accessible emission limits contained in table I of paragraph (d) of this section. Class I levels of laser radiation are not considered to be hazardous.

(6) *Class IIa laser product* means any laser product that permits human access during operation to levels of visible laser radiation in excess of the accessible emission limits contained in table I, but does not permit human access during operation to levels of laser radiation in excess of the accessible emission limits contained in table II-A of paragraph (d) of this section. 2

2 Class IIa levels of laser radiation are not considered to be hazardous if viewed for any period of time less than or equal to 1×10 3 seconds but are considered to be a chronic viewing hazard for any period of time greater than 1×10 3 seconds.

(7) *Class II laser product* means any laser product that permits human access during operation to levels of visible laser radiation in excess of the accessible emission limits contained in table II-A, but does not permit human access during operation to levels of laser radiation in excess of the accessible emission limits contained in table II of paragraph (d) of this section. Class II levels of laser radiation are considered to be a chronic viewing hazard.

(8) *Class IIIa laser product* means any laser product that permits human access during operation to levels of visible laser radiation in excess of the accessible emission limits contained in table II, but does not permit human access during operation to levels of laser radiation in excess of the accessible emission limits contained in table III-A of paragraph (d) of this section. Class IIIa levels of laser radiation are considered to be, depending upon the irradiance, either an acute intrabeam viewing

hazard or chronic viewing hazard, and an acute viewing hazard if viewed directly with optical instruments.

(9) *Class IIIb laser product* means any laser product that permits human access during operation to levels of laser radiation in excess of the accessible emission limits of table III-A, but does not permit human access during operation to levels of laser radiation in excess of the accessible emission limits contained in table III-B of paragraph (d) of this section. Class IIIb levels of laser radiation are considered to be an acute hazard to the skin and eyes from direct radiation.

(10) *Class III laser product* means any Class IIIa or Class IIIb laser product.

(11) *Class IV laser product* means any laser that permits human access during operation to levels of laser radiation in excess of the accessible emission limits contained in table III-B of paragraph (d) of this section. Class IV levels of laser radiation are considered to be an acute hazard to the skin and eyes from direct and scattered radiation.

(12) *Collateral radiation* means any electronic product radiation, except laser radiation, emitted by a laser product as a result of the operation of the laser(s) or any component of the laser product that is physically necessary for the operation of the laser(s).

(14) *Emission duration* means the temporal duration of a pulse, a series of pulses, or continuous operation, expressed in seconds, during which human access to laser or collateral radiation could be permitted as a result of operation, maintenance, or service of a laser product.

(15) *Human access* means the capacity to intercept laser or collateral radiation by any part of the human body. For laser products that contain Class IIIb or IV levels of laser radiation, “human access” also means access to laser radiation that can be reflected directly by any single introduced flat surface from the interior of the product through any opening in the protective housing of the product.

(19) *Laser* means any device that can be made to produce or amplify electromagnetic radiation at wavelengths greater than 250 nm but less than or equal to 13,000 nm or, after August 20, 1986, at wavelengths equal to or greater than 180 nm but less than or equal to 1.0X106 nm primarily by the process of controlled stimulated emission.

(20) *Laser energy source* means any device intended for use in conjunction with a laser to supply energy for the operation of the laser. General energy sources such as electrical supply mains or batteries shall not be considered to constitute laser energy sources.

(21) *Laser product* means any manufactured product or assemblage of components which constitutes, incorporates, or is intended to incorporate a laser or laser system. A laser or laser system that is intended for use as a component of an electronic product shall itself be considered a laser product.

(22) *Laser radiation* means all electromagnetic radiation emitted by a laser product within the spectral range specified in paragraph (b)(19) of this section that is produced as a result of controlled stimulated emission or that is detectable with radiation so produced through the appropriate aperture stop and within the appropriate solid angle of acceptance, as specified in paragraph (e) of this section.

(23) *Laser system* means a laser in combination with an appropriate laser energy source with or without additional incorporated components.

(25) *Maximum output* means the maximum radiant power and, where applicable, the maximum radiant energy per pulse of accessible laser radiation emitted by a laser product during operation, as determined under paragraph (e) of this section.

(26) *Medical laser product* means any laser product which is a medical device as defined in 21 U.S.C. 321(h) and is manufactured, designed, intended or promoted for in vivo laser irradiation of any part of the human body for the purpose of: (i) Diagnosis, surgery, or therapy; or (ii) relative positioning of the human body.

(28) *Protective housing* means those portions of a laser product which are designed to prevent human access to laser or collateral radiation in excess of the prescribed accessible emission limits under conditions specified in this section and in § 1040.11.

(31) *Radiant energy* means energy emitted, transferred or received in the form of radiation, expressed in joules (J).

(32) *Radiant exposure* means the radiant energy incident on an element of a surface divided by the area of the element, expressed in joules per square centimeter (Jcm^{-2})

(33) *Radiant power* means time-averaged power emitted, transferred or received in the form of radiation, expressed in watts (W).

(37) *Scanned laser radiation* means laser radiation having a time-varying direction, origin or pattern of propagation with respect to a stationary frame of reference.

(40) *Visible radiation* means laser or collateral radiation having wavelengths of greater than 400 nm but less than or equal to 710 nm.

Note to Readers: Socket Class 1 and Class 2 laser scanner products use laser wavelengths of 650 & 670 nm (nanometers)

(41) *Warning logotype* means a logotype as illustrated in either figure 1 or figure 2 of paragraph (g) of this section.

(42) *Wavelength* means the propagation wavelength in air of electromagnetic radiation.

(c) ***Classification of laser products***— (1) *All laser products.* Each laser product shall be classified in Class I, IIa, II, IIIa, IIIb, or IV in accordance with definitions set forth in paragraphs (b) (5) through (11) of this section. The product classification shall be based on the highest accessible emission level(s) of laser radiation to which human access is possible during operation in accordance with paragraphs (d), (e), and (f)(1) of this section.

(d) ***Accessible emission limits.*** Accessible emission limits for laser radiation in each class are specified in tables I, II-A, II, III-A, and III-B of this paragraph. The factors, $k1$ and $k2$ vary with wavelength and emission duration. These factors are given in table IV of this paragraph, with selected numerical values in table V of this paragraph. Accessible emission limits for collateral radiation are specified in table VI of this paragraph.

(g) ***Labeling requirements***. In addition to the requirements of §§ 1010.2 and 1010.3, each laser product shall be subject to the applicable labeling requirements of this paragraph.

(1) ***Class IIa and II designations and warnings.***

(i) Each Class IIa laser product shall have affixed a label bearing the following wording: "Class IIa Laser Product—Avoid Long-Term Viewing of Direct Laser Radiation."

(ii) Each Class II laser product shall have affixed a label bearing the warning logotype A (figure 1 in this paragraph) and including the following wording:

[Position I on the logotype] "LASER RADIATION—DO NOT STARE INTO BEAM"; and [Position 3 on the logotype] "CLASS II LASER PRODUCT".

(iii) Visible laser radiation only, the phrase "laser light" may replace the phrase "laser radiation."

Note to Readers:
No labeling requirements for Class 1 lasers are specified in this document. Symbol Technologies Inc. has established the labeling standard used on Socket Class 1 laser scanner products. See Appendix B for label text used on Socket laser scanner products.

(4) *Radiation output information on warning logotype.* Each Class II, III, and IV laser product shall state in appropriate units, at position 2 on the required warning logotype, the maximum output of laser radiation, the pulse duration when appropriate, and the laser medium or emitted wavelength(s).

TABLE I

CLASS I ACCESSIBLE EMISSION LIMITS FOR LASER RADIATION

Wavelength	Emission duration	Class I-Accessible emission limits		
(nanometers)	(seconds)	(value)	(unit)	(quantity)**
≥ 180 but ≤ 400	$\leq 3.0 \times 10^{4}$	$2.4 \times 10^{-5} k_1 k_2$*	Joules(J)*	radiant energy
	$> 3.0 \times 10^{4}$	$8.0 \times 10^{-10} k_1 k_2$*	Watts(W)*	radiant power
> 400 but ≤ 1400	$> 1.0 \times 10^{-9}$ to 2.0×10^{-5}	$2.0 \times 10^{-7} k_1 k_2$	J	radiant energy
	$> 2.0 \times 10^{-5}$ to 1.0×10^{1}	$7.0 \times 10^{-4} k_1 k_2 t^{3/4}$	J	radiant energy
	$> 1.0 \times 10^{1}$ to 1.0×10^{4}	$3.9 \times 10^{-3} k_1 k_2$	J	radiant energy
	$> 1.0 \times 10^{4}$	$3.9 \times 10^{-7} k_1 k_2$	W	radiant power
	and also (See paragraph (d)(4) of this section)			
	$> 1.0 \times 10^{-9}$ to 1.0×10^{1}	$10 k_1 k_2 t^{1/3}$	$Jcm^{-2}sr^{-1}$	integrated radiance
	$> 1.0 \times 10^{1}$ to 1.0×10^{4}	$20 k_1 k_2$	$Jcm^{-2}sr^{-1}$	integrated radiance
	$> 1.0 \times 10^{4}$	$2.0 \times 10^{-3} k_1 k_2$	$Wcm^{-2}sr^{-1}$	radiance
> 1400 but ≤ 2500	$> 1.0 \times 10^{-9}$ to 1.0×10^{-7}	$7.9 \times 10^{-5} k_1 k_2$	J	radiant energy
	$> 1.0 \times 10^{-7}$ to 1.0×10^{1}	$4.4 \times 10^{-3} k_1 k_2 t^{1/4}$	J	radiant energy
	$> 1.0 \times 10^{1}$	$7.9 \times 10^{-4} k_1 k_2$	W	radiant power
> 2500 but $\leq 1.0 \times 10^{6}$	$> 1.0 \times 10^{-9}$ to 1.0×10^{-7}	$1.0 \times 10^{-2} k_1 k_2$	Jcm^{-2}	radiant exposure
	$> 1.0 \times 10^{-7}$ to 1.0×10^{1}	$5.6 \times 10^{-1} k_1 k_2 t^{1/4}$	Jcm^{-2}	radiant exposure
	$> 1.0 \times 10^{1}$	$1.0 \times 10^{-1} k_1 k_2 t$	Jcm^{-2}	radiant exposure

*Class I accessible emission limits for wavelengths equal to or greater than 180 nm but less than or equal to 400 nm shall not exceed the Class I accessible emission limits for the wavelengths greater than 1400 nm but less than or equal to 1.0×10^{6} nm with a k_1 and k_2 of 1.0 for comparable sampling intervals.

**Measurement parameters and test conditions shall be in accordance with paragraphs (d)(1), (2), (3), and (4), and (e) of this section.

TABLE IV

VALUES OF WAVELENGTH DEPENDENT CORRECTION FACTORS k_1 AND k_2

Wavelength (nanometers)	k_1	k_2		
180 to 302.4	1.0	1.0		
> 302.4 to 315	$10^{\left[\frac{\lambda - 302.4}{5}\right]}$	1.0		
> 315 to 400	330.0	1.0		
> 400 to 700	1.0	1.0		
> 700 to 800	$10^{\left[\frac{\lambda - 700}{515}\right]}$	if: $t \leq \frac{10100}{\lambda - 699}$ then: $k_2 = 1.0$	if: $\frac{10100}{\lambda - 699} < t \leq 10^4$ then: $k_2 = \frac{t(\lambda - 699)}{10100}$	if: $t > 10^4$ then: $k_2 = \frac{\lambda - 699}{1.01}$
> 800 to 1060	$10^{\left[\frac{\lambda - 700}{515}\right]}$	if: $t \leq 100$ then: $k_2 = 1.0$	if: $100 < t \leq 10^4$ then: $k_2 = \frac{t}{100}$	if: $t > 10^4$ then: $k_2 = 100$
> 1060 to 1400	5.0			
> 1400 to 1535	1.0	1.0		
> 1535 to 1545	$t \leq 10^{-7}$ $k_1 = 100.0$	1.0		
	$t > 10^{-7}$ $k_1 = 1.0$			
> 1545 to 1.0×10^6	1.0	1.0		

Note: The variables in the expressions are the magnitudes of the sampling interval(t), in units of seconds, and the wavelength (λ), in units of nanometers.

TABLE V

SELECTED NUMERICAL SOLUTIONS FOR k_1 AND k_2

Wavelength (nanometers)	k_1	k_2				
		$t \le 100$	$t = 300$	$t = 1000$	$t = 3000$	$t \ge 10{,}000$
180	1.0					
300	1.0					
302	1.0					
303	1.32					
304	2.09					
305	3.31					
306	5.25					
307	8.32					
308	13.2					
309	20.9					
310	33.1			1.0		
311	52.5					
312	83.2					
313	132.0					
314	209.0					
315	330.0					
400	330.0					
401	1.0					
500	1.0					
600	1.0					
700	1.0					
710	1.05	1	1	1.1	3.3	11.0
720	1.09	1	1	2.1	6.3	21.0
730	1.14	1	1	3.1	9.3	31.0
740	1.20	1	1.2	4.1	12.0	41.0
750	1.25	1	1.5	5.0	15.0	50.0
760	1.31	1	1.8	6.0	18.0	60.0
770	1.37	1	2.1	7.0	21.0	70.0
780	1.43	1	2.4	8.0	24.0	80.0
790	1.50	1	2.7	9.0	27.0	90.0
800	1.56	1	3.0	10.0	30.0	100.0
850	1.95	1	3.0	10.0	30.0	100.0
900	2.44	1	3.0	10.0	30.0	100.0
950	3.05	1	3.0	10.0	30.0	100.0
1000	3.82	1	3.0	10.0	30.0	100.0
1050	4.78	1	3.0	10.0	30.0	100.0
1060	5.00	1	3.0	10.0	30.0	100.0
1100	5.00	1	3.0	10.0	30.0	100.0
1400	5.00	1	3.0	10.0	30.0	100.0
1500	1.0					
1540	100.0 *			1.0		
1600	1.0					
$1.0X10^6$	1.0					

* The factor k_1 = 100.0 when $t \le 10^{-7}$, and k_1 = 1.0 when $t > 10^{-7}$

Note: The variable (t) is the magnitude of the sampling interval in units of seconds.

Appendix B: Laser Safety Statement and Product Labels

The following laser safety statement is included in the product User Guides of all Socket scanner products based on laser technology:

LASER DEVICES: Socket products using lasers comply with US 21CFR1040.10, Subchapter J and IEC825/EN 60 825 (or IEC825-1/EN 60 825-1, depending on date of manufacture). The laser classification is marked on one of the labels on the product.

Class 1 Laser devices are not considered to be hazardous when used for their intended purpose. The following statement is required to comply with US and international regulations.

Caution: Use of controls, adjustments or performance of procedures other than those specified herein may result in hazardous laser light exposure.

Class 2 laser scanners use a low power, visible light diode. As with any very bright light source, such as the sun, the user should avoid staring directly into the light beam. Momentary exposure to a Class 2 laser is not known to be harmful.

The following text is included in English, German and French on a yellow warning label on all Socket scanner products using a Class 2 laser:

CAUTION – LASER LIGHT.
DO NOT STARE INTO BEAM.
IEC CLASS 2 LASER PRODUCT

The following text is included in English, German and French on a white warning label on all Socket scanner products using a Class 1 laser:

CLASS 1 LASER PRODUCT