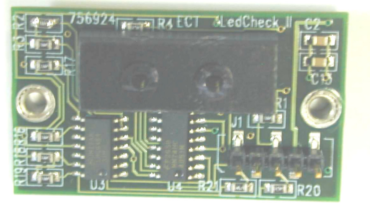

First Edition

LedCheck II ™

Installation and Operation
Manual

2 Channel LedCheck
Analog Wavelength & Intensity
White LED Detection

Everett Charles Technologies

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756794 Revision B

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Introduction

Overview

LedCheck II™ is a modular assembly designed specifically for color testing light emitting diodes on printed circuit boards under test on automatic test equipment. Each module can accommodate 2 LED's. Each channel measures true color of the LED under test, and provides an analog output to the test system proportional to the wavelength of the light detected form the LED. Am second analog output provides a relative intensity.

While the color measurement system has good wavelength accuracy designed in, various factors influence the true accuracy of the measurement. The treatment of the fibers, peak versus dominant wavelength of the LED with clear, tinted, or diffused lens and temperature influence the measurement of color. The LEDCHECK color test module is not a spectrometer, but rather an inexpensive multi-channel color-measuring device with excellent repeatability. Once the hardware and measurement are setup, LEDCHECK can be relied upon to perform the color tests within the prescribed criteria.

Operation

LEDCHECK input requirements are power and ground connections, a digital channel select signal, and a plastic optical fiber connection to the LED under test. It returns an analog signal providing a direct millivolt reading in nanometers, multiplied by 16, -6000. The wavelength range covered is from 400nm to 650nm, corresponding to 400mV to 4400mV. To accommodate white LED's, this analog output will be set to 0.200V if a white LED is detected.

Two additional voltage levels are set to indicate minimum and maximum light level. Zero volts are set to indicate the channel is below the minimum measurement level or the LED is not functioning. Additionally, >4.600V is set to indicate the light presented to the module is in excess of its range, saturating the input. This feature allows for attenuation of the light during the debug phase of installation, described later in this document.

LEDCHECK is a free running unit constantly updating the analog outputs. Once a channel is addressed, the measurement will be correct after delaying for two update periods (see Timing Section of this manual) to allow for a correct measurement

Technical Details

Wavelength Range	400- 650nm
Resolution	0.25nm
Accuracy	±3%, ±1%Channel to Channel matching
Luminous Intensity	1 – 2000 mcd Requires optical attenuation above 2000mcd
Interface	**Input:** 1 Digital channel A/B select (TTL compatible) **Output:** 2 Analog Wavelength (nm x 16) - 6000 = mV) Below Minimum Level = 0V Saturation Level = > 4.5V Intensity 0-4.800V Below Minimum Level = 0V Saturation Level = 0V **Optical:** 2 Universal Optical Ports Accept: 1mm, 1.5mm, & 2mm Jacketed Plastic Optical Fiber 2mm, 3mm Unjacketed Fiber
Power Supply	5VDC, reverse polarity protected, <30mA
AD Converter	12 bit, 100kspS
DA Converters	12 bit, 10us settling time
Processor	20MIPS Flash Programmed
Update Speed	Continual updates at 750Hz rate
Dimensions	1.00” W x 1.75” L x 0.57”H (to top of fiber connector)

Module Description and Wiring

Channel Select Inputs

1 Channel A/B select (A=0, B=1)

5V CMOS/TTL compatible, positive true, 4.99K pull-up to 5V on board
3.15V high threshold, 1.35V low threshold
Protected - clamped to +5V & Ground

Analog Outputs 0-5V

2 - Buffered Driven D/A Outputs

Analog output Impedance - 50Ω

Wavelength Output

Scaled (nm * 16) - 6000 color response from 400nm to 650nm to 400mV to 4400mV ±25mV
White light detection 0.200V ±25.0mv
Input light level below minimum processing level <25mV
Input level above saturation limit >4.660V

Intensity Output

Scaled 0 to 4.60V for minimum to maximum (saturated) level. There is no true correlation to actual LED light level in mili-candella, there are too many factors involved cable size, spacing, etc. The analog level is not scaled to the RGB sensor levels, so a 10mcd green LED may not give the same value as a 10mcd red LED. Generally to attain the 100% output level, a white source that maximizes all colors in the sensor would need to be present. Output set to 0V over saturation level.

Power +5V

+5V ±250mV <30mA
Reverse Polarity Protected
Startup Time from application of power 100mS ±20%
Note: This startup delay can be eliminated if the power remains applied through the transfer pins when the fixture is cycled.

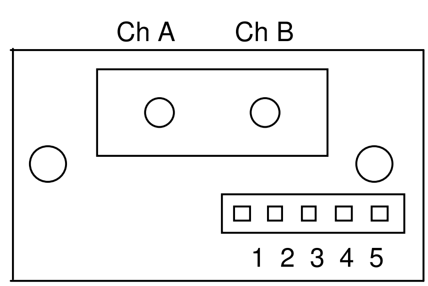


Figure 1 – LEDCHECK Module

Interface Connector

0.100" Centerline Header, for Address, Wavelength Output, & Power Connections. Orientation and connections are shown in Figure 1 and Table 1.

Connector Pinout

Pin	Signal	Function	Notes
1	WAVELENGTH	Wavelength Analog Output	
2	INTENSITY	Intensity Analog Output	
3	~CH-A/CH-B	Binary A/B Channel Select	0 = CH-A
4	+5V	+5V Power	
5	GND	Digital, Analog & 5V Power Ground	

Table 1 – Connector Pinout

Wiring Note

1. DGND the Digital Ground & Power Supply Return must be connected to the test system common to allow the use of test system resources to control the address inputs and read back the analog outputs.
2. The Channel Select input is clamped to the +5V and GND to provide over voltage and ESD protection. Actively driving this input high without the +5 V power applied could damage the input protection. It is recommended that the input be driven using an active low only driver and using the built in pull up resistor to produce the high level.

Fixture Wiring

Single Channel Operation

The most basic connection for operation of a single channel requires only three connections to the header: Ground, +5V, and the analog wavelength output. Since the channel A/B input has an internal pullup, the board will default to Channel B.

Grounds

The LEDCHECK power supply common MUST be common to the Test system common to use test system resources to control the address input, and read back the analog signals.

Fiber Optic Connections

Fiber Cable Insertion - Warning

Do not twist fiber once inserted into the fiber holder. There is a plastic light sensor at the bottom of the opening, which can be scratched if the hard plastic optical fiber is rotated against it. Press the fiber optic cable firmly into the opening until it bottoms, and tighten the Allen head set screws to the cable.

For 1mm jacketed cable or 2mm unjacketed cable use the nylon insert supplied and the stainless set screw to secure the fiber in the insert. When using the 1mm jacketed cable, best wavelength accuracy will be attained if the cable is pulled back from the sensor by approximately 1-2mm to allow equal dispersion of the light across the color sensor elements. This dimension is not critical, but will provide far more accurate results.

For 1.5mm or 2mm cable with 3mm OD jacket, remove the insert and insert the cable directly and secure with the stainless steel or nylon set screw.

For 3mm unjacketed cable insert the cable without the insert and secure with the nylon set screw to prevent damage to the cladding on the cable.

Notes on Fiber Cables

1mm Jacketed Cable

To achieve more accurate wavelength determination when using 1mm fiber the cable should be pulled back away from the sensor surface by 1-2mm to allow the exiting light to disperse across the sensor surface. The active area of the sensor is a rectangle about 2.4mm square. This will diminish the intensity of the light arriving at the sensor, and may not be practical for low intensity applications.

Unjacketed Cable

Unjacketed cable exposed to ambient light will pick up a portion of the ambient light along with the LED under test. If the ambient light is florescent the wavelength and amplitude outputs will be modulated by the 50 or 60Hz variations in this ambient and cause readings to fluctuate. Use of unjacketed cable should be limited to areas where cable will be shielded from ambient light.

Unjacketed cable exposed to ambient light will usually cause the LedCheck to 'see' enough input to bring it out of the under minimum limit mode and begin processing wavelength and intensity of the ambient light, rather than sitting idle with a zero level at the output.

Light Attenuation

If the light input to the module saturates the input, producing a maximum indication (>4.600V) on the wavelength output, the signal level to the module must be reduced. The minimum is about 1milicandella, and the maximum is approximately 2000mcd, dependant upon color. LED's with higher output will require attenuation of the light.

Lowering the current or voltage if a series resistor is used can reduce the drive to the LED under test. This does have the disadvantage of not testing the LED at its actual drive current, which may produce a slight wavelength shift from that specified.

Other methods to attenuate the light are to pull the fiber probe further away from the LED, and / or pull the fiber away from the sensor when it is inserted into the clamp in the Ledcheck module. The hole for the fiber in the block at the Ledcheck module has a full insertion depth of 0.250" before hitting the sensor, allowing for a substantial lowering of the amount of light hitting the sensor as the fiber is pulled back.

Fiber Cutting and Polishing

The end of the fiber optic cable, which terminates in the LEDCHECK module, must be cleaved cleanly, to insure the light exiting the fiber exits evenly and perpendicular to the cables outer casing. The plastic optical fiber is very hard, and may fracture unevenly when cut. These fractures will cause an irregular dispersion of the light on the sensor. When the fiber is cleaved, the end may not be perpendicular, which can cause the light to exit at an angle, and bias the color detection.

Once the proper length is determined, the cable is slipped through one of the holes in the fiber cleaver, after the razor blade has been removed. The blade is then placed into the slot in the cleaver, and pressed straight down until the cable is cut. Do not slide the blade, or rotate the cable. The core will fracture where the blade begins, and continue the fracture through the core. The razor blade will only last for a limited number of cuts, as the blade will quickly degrade against the hard cable core.

The cut end should be inspected for a bad cut where a large portion of the core appears to be broken out. If this is the case, a second cut should be made to the end of the cable, a quarter of an inch or so beyond the first.

Minimum Bend Radius

Solid core plastic optical fibers have specified minimum bend radius. Exceeding the bend radius may result in micro-fractures of the core, and severe loss of signal. Once the cable has been overstressed, it will not recover, and will need to be replaced. The minimum bend radius for typical Eska optical grade fibers is specified at 25 x the outer diameter of the actual fiber. For a 1mm jacketed cable this radius would be 25mm or roughly 1 inch.

Notes on Fiber Bushing

The Nylon bushing used to reduce the 3mm hole to 2.2mm may be tightly pressed into the fiber block due to tolerances in drilling and the bushing. Removal can be performed by carefully grabbing the bushing at the base with the cutting edge of a pair of flush cutting diagonal pliers. This will act as a wedge and lift the bushing from the fiber holder.

Measurement Timing

LEDCHECK Timing

After power up delays, the module immediately starts a sampling on the addressed channel A/B. If the LED under test has not yet been energized, the loop will determine that the light input is below the minimum processing level, and abort the wavelength calculation. This loop repeats in about 550 microseconds, and continues indefinitely until light of sufficient level is detected. The wavelength analog output will be set to 0V each time through the loop, shown below in Figure 4.

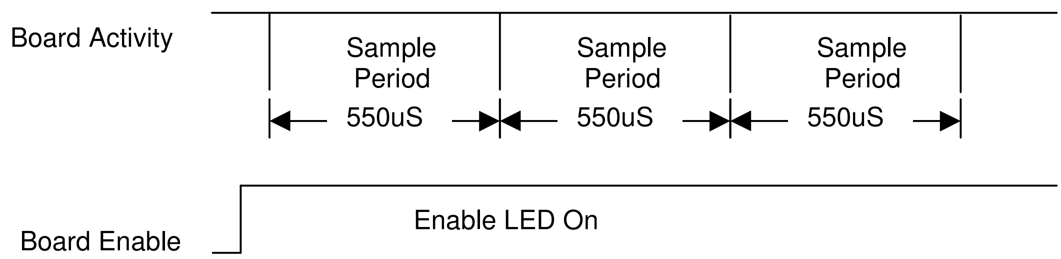


Figure 4 - Below Minimum Level Timing

Once light of sufficient amplitude is detected at the addressed channel, the process will continue and a wavelength will be sent to the analog to digital converter in the module. This processing takes approximately 750 microseconds, depending on the color detected, as shown in Figure 5.

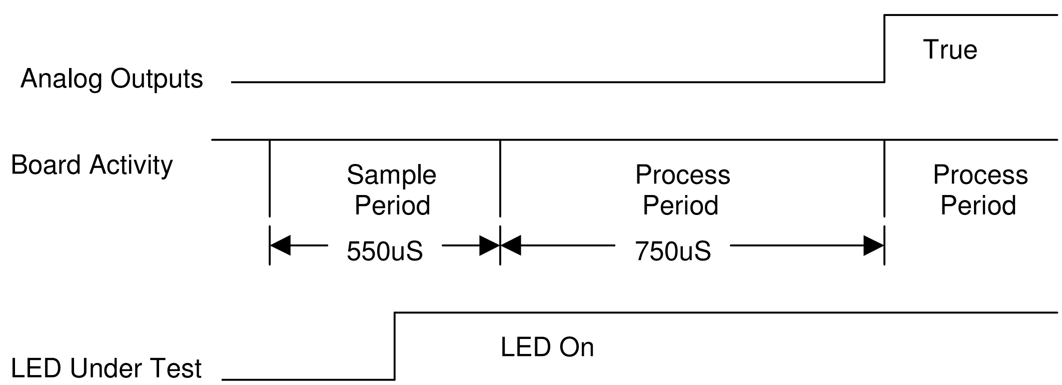


Figure 5 - Processing Timing

Once the LED is lit, the output of the LEDCHECK module should not be read until two full cycles of processing time have been allowed to complete. Since this asynchronous operation may have begun the first calculation part way through it's first digitization of the sensor data as the LED lit, it may produce erroneous wavelength data. A second pass through the processing will give accurate results. A safe wait time for asynchronous operation of the LEDCHECK module is a minimum of 2.4 milliseconds.

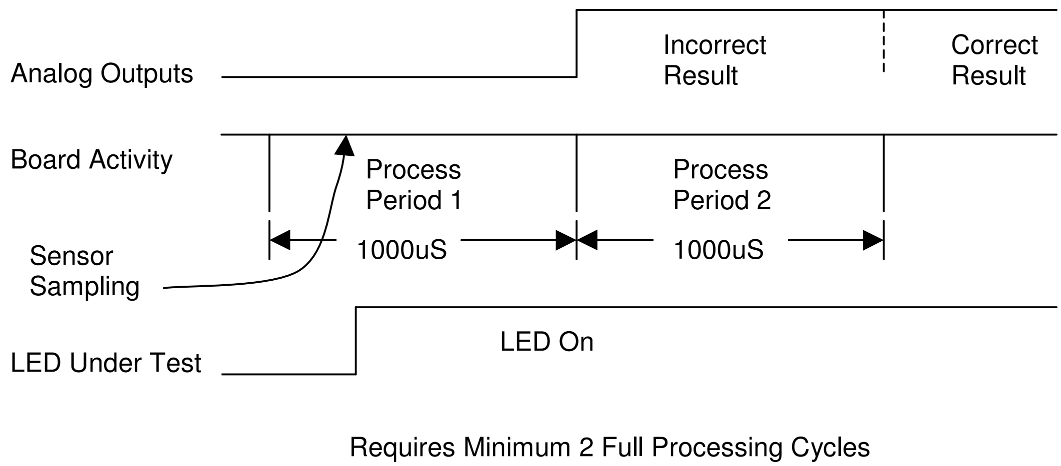


Figure 6 - Asynchronous Processing Timing

The LEDCHECK module operating asynchronously requires 2 full process cycles to insure a correct output reading. A minimum 'Safe' delay time is 2.4mS from activation of the LED under test, or change of optical channel address. A recommended minimum delay time is 5mS allowing the LED to stabilize, and guarantee a minimum number of LedCheck measurement cycles.

Once a channel has been exposed to the illuminated LED under test, there is a time lag from extinguishing the LED and a return to zero level at the output of the LEDCHECK module. In the case of a dual or multicolor LED under test, there is a minimum 2 sample delay period prior to the measurement of a second color on the same channel. The LEDCHECK module will 'remember' the color of the extinguished LED for a time before returning to the dark current level. The two successive processing cycles may return the same value or an incorrect value, before returning to zero.

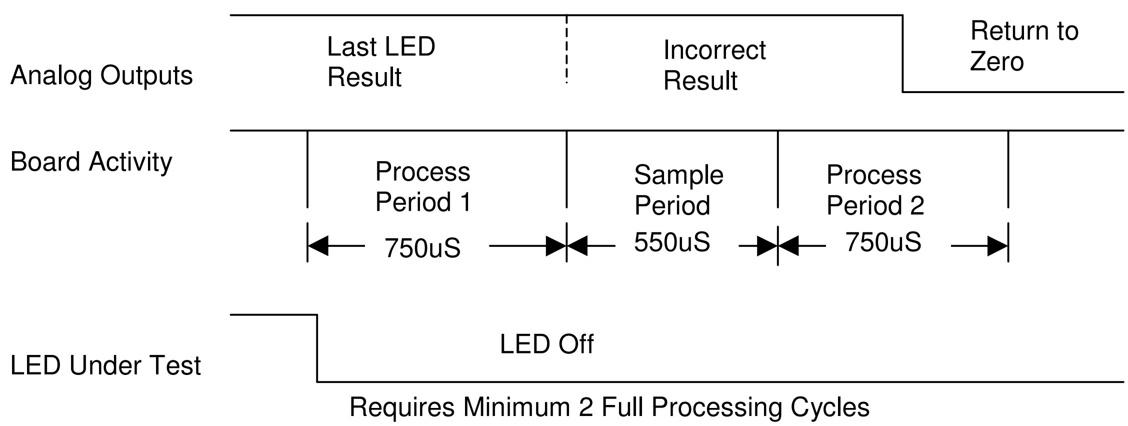
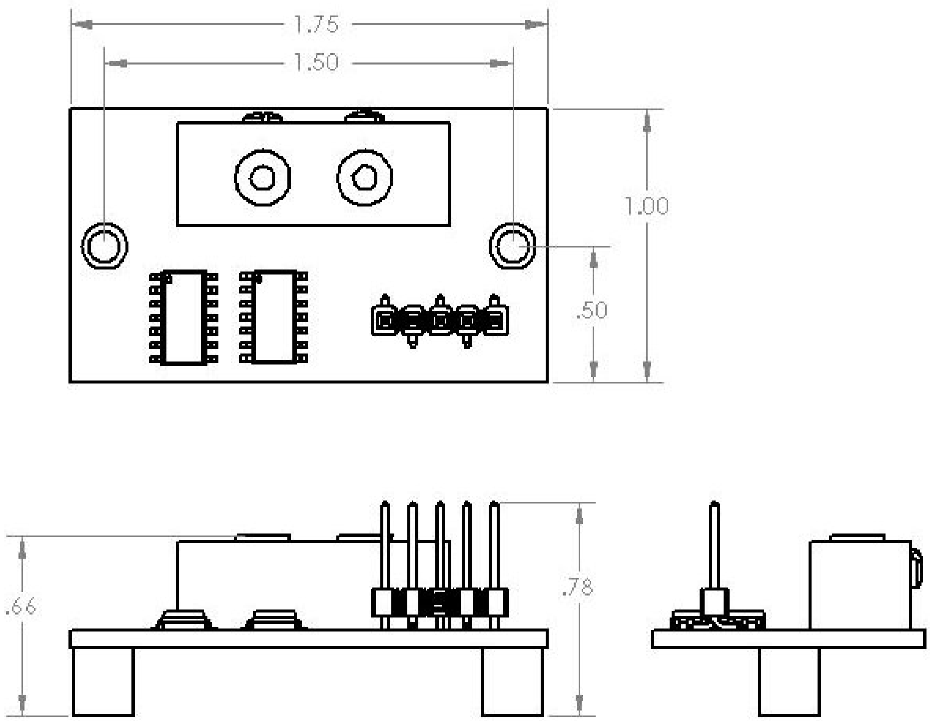


Figure 7 – Return to Zero Timing

Processor Start up Delay

Startup time from application of the 5V power is 100mS ±20% to allow the clock to stabilize, and the processor to wake up.

Mounting Dimensions



Notes:

1. Channels that are not in use, if directly exposed to ambient light, may return a value other than 0V. The ambient light may produce any value in the visible spectrum, or white level indication, or may vary from 0V to a reading if near the minimum threshold.

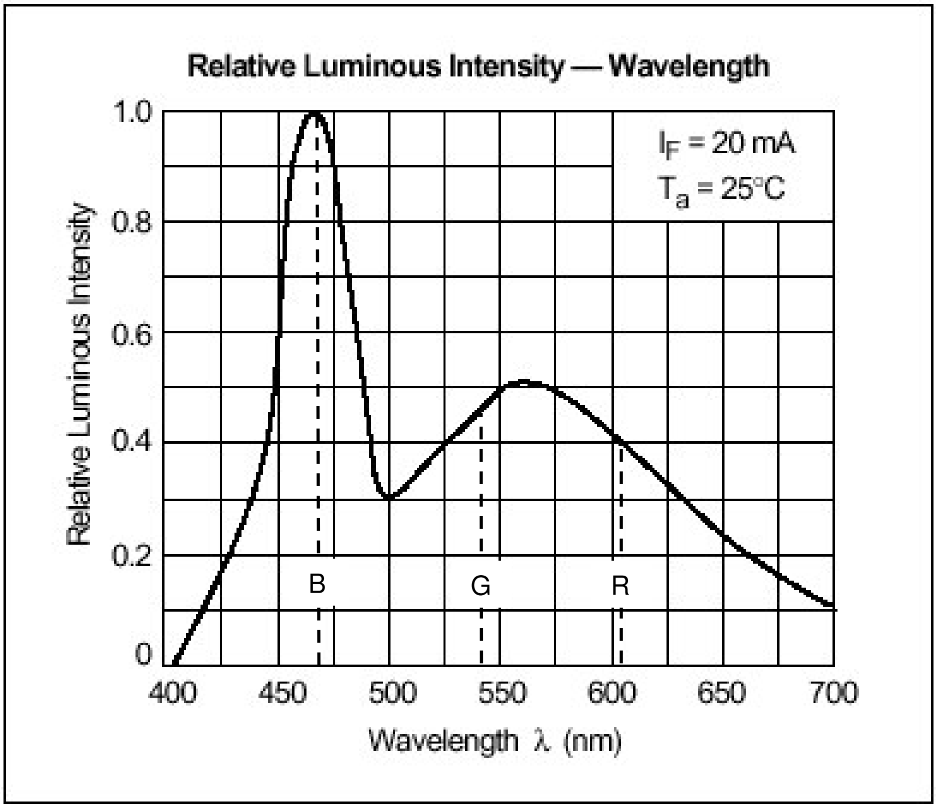
2. Test results that vary between a good reading and 0V, on successive measurements, are operating close to the minimum-processing threshold. The light pickup should be centered closer to the LED center, and/or brought closer to the emitting surface of the LED.

3. Spectral half width of the illuminating LED influences the calculated wavelength reported. For instance a 600nm LED is composed of red and green primaries. A LED with a spectral half width of 30nm will provide more energy in green than a 20nm half width device, lowering the calculated wavelength.

Appendix 1 White LED Detection

White level detection is specifically intended for 'white' LED detection, not incandescent sources. The detection parameters are distinctly tailored to phosphor coated blue LED's which re-emit light across a broad spectrum, with a predominant blue hue. A second type of 'white' LED exists, which is a combination of discreet red, green and blue LED's to produce white. To accommodate all possible existing and future white LED's any combination of a red, green, or blue peak, with 25% energy levels in the two remaining colors will be detected and reported as white. This combination cannot logically exist in a monochromatic LED.

A typical white LED has a luminous intensity over wavelength, which consists of a blue peak at 470nm, green peak at 560nm at half the intensity as shown in the following spectral graph.



The criteria used to detect this white LED, is a primary signal of blue, with green and red both at levels greater than 25% of the blue energy value, at the approximate points shown on the graph with dashed lines. There is also a minimum level cutoff for white detection to eliminate problems in accidentally reporting white where the signal levels approach the noise floor of the LEDCHECK module. This minimum is roughly 10mcd, and few if any white LED's are manufactured at this low intensity.

When a white LED is detected, the wavelength output will be set to 200mV ±30mV. The intensity output will function normally, providing a value of relative luminous intensity collected across the spectrum.

Appendix 2 Nanometer to Voltage Conversion Chart

nm	mV
400	400
401	416
402	432
403	448
404	464
405	480
406	496
407	512
408	528
409	544
410	560
411	576
412	592
413	608
414	624
415	640
416	656
417	672
418	688
419	704
420	720
421	736
422	752
423	768
424	784
425	800
426	816
427	832
428	848
429	864
430	880
431	896
432	912
433	928
434	944
435	960
436	976
437	992
438	1008
439	1024
440	1040
441	1056
442	1072
443	1088
444	1104
445	1120
446	1136
447	1152
448	1168
449	1184

nm	mV
450	1200
451	1216
452	1232
453	1248
454	1264
455	1280
456	1296
457	1312
458	1328
459	1344
460	1360
461	1376
462	1392
463	1408
464	1424
465	1440
466	1456
467	1472
468	1488
469	1504
470	1520
471	1536
472	1552
473	1568
474	1584
475	1600
476	1616
477	1632
478	1648
479	1664
480	1680
481	1696
482	1712
483	1728
484	1744
485	1760
486	1776
487	1792
488	1808
489	1824
490	1840
491	1856
492	1872
493	1888
494	1904
495	1920
496	1936
497	1952
498	1968
499	1984

nm	mV
500	2000
501	2016
502	2032
503	2048
504	2064
505	2080
506	2096
507	2112
508	2128
509	2144
510	2160
511	2176
512	2192
513	2208
514	2224
515	2240
516	2256
517	2272
518	2288
519	2304
520	2320
521	2336
522	2352
523	2368
524	2384
525	2400
526	2416
527	2432
528	2448
529	2464
530	2480
531	2496
532	2512
533	2528
534	2544
535	2560
536	2576
537	2592
538	2608
539	2624
540	2640
541	2656
542	2672
543	2688
544	2704
545	2720
546	2736
547	2752
548	2768
549	2784

nm	mV
550	2800
551	2816
552	2832
553	2848
554	2864
555	2880
556	2896
557	2912
558	2928
559	2944
560	2960
561	2976
562	2992
563	3008
564	3024
565	3040
566	3056
567	3072
568	3088
569	3104
570	3120
571	3136
572	3152
573	3168
574	3184
575	3200
576	3216
577	3232
578	3248
579	3264
580	3280
581	3296
582	3312
583	3328
584	3344
585	3360
586	3376
587	3392
588	3408
589	3424
590	3440
591	3456
592	3472
593	3488
594	3504
595	3520
596	3536
597	3552
598	3568
599	3584

nm	mV
600	3600
601	3616
602	3632
603	3648
604	3664
605	3680
606	3696
607	3712
608	3728
609	3744
610	3760
611	3776
612	3792
613	3808
614	3824
615	3840
616	3856
617	3872
618	3888
619	3904
620	3920
621	3936
622	3952
623	3968
624	3984
625	4000
626	4016
627	4032
628	4048
629	4064
630	4080
631	4096
632	4112
633	4128
634	4144
635	4160
636	4176
637	4192
638	4208
639	4224
640	4240
641	4256
642	4272
643	4288
644	4304
645	4320
646	4336
647	4352
648	4368
649	4384
650	4400