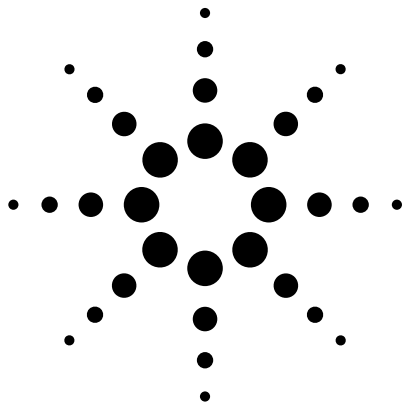




# Surface Mount LED Indicator

## Agilent HSMx-A2xx-xxxxx Bi-Color, HSMx-A3xx-xxxxx Tri Color PLCC-4 SMT LED

### Data Sheet



#### Description

This family of SMT LEDs is packaged in the industry standard PLCC-4 package. These SMT LEDs have high reliability performance and are designed to work under a wide range of environmental conditions. This high reliability feature makes them ideally suited to be used under harsh interior automotive as well as interior signs application conditions.

To facilitate easy pick and place assembly, the LEDs are packed in EIA-compliant tape and reel. Every reel will be shipped in single intensity and color bin, except red color to provide close uniformity.

These LEDs are compatible with IR and TTV solder reflow process.

This super wide viewing angle at 120° together with the built in reflector pushing up the intensity of the light output makes these LED suitable to be used in the interior electronics signs. The flat top emitting surface makes it easy for these LEDs to mate with light pipes. This is suitable for general backlighting in automotive interior, office equipment, industrial equipment, and home appliances.

#### Features

- Industry Standard PLCC-4 package (Plastic Leaded Chip Carrier)
- High reliability LED package
- High brightness using AlInGaP and InGaN dice technologies
- Available in full selection of colors
- Super wide viewing angle at 120°
- Available in 8 mm carrier tape on 7-inch reel
- Compatible with IR soldering process

#### Applications

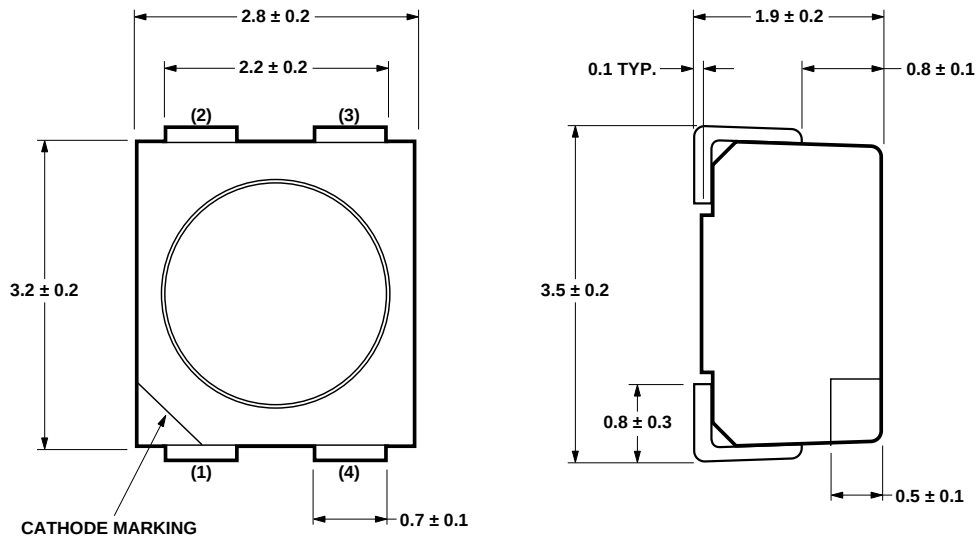
- Electronic signs and signals
  - Interior full color sign
  - Variable message sign
- Interior automotive
  - Instrument cluster backlighting
  - Central console backlighting
  - Cabin backlighting
- Office automation, home appliances, industrial equipment
  - Front panel backlighting
  - Display backlighting

**CAUTION:** HSMF-Axxx-xxxxx LEDs are Class 2 ESD sensitive. Please observe appropriate precautions during handling and processing. Refer to Agilent Application Note AN-1142 for additional details.



Agilent Technologies

## Package Dimensions



### NOTE:

1. ALL DIMENSIONS IN mm.

### Tri Color

- |   |                   |
|---|-------------------|
| 1 | Cathode (Color 1) |
| 2 | Common Anode      |
| 3 | Cathode (Color 3) |
| 4 | Cathode (Color 2) |

### Bi Color

- |   |                   |
|---|-------------------|
| 1 | Cathode (Color 1) |
| 2 | Anode (Color 1)   |
| 3 | Cathode (Color 2) |
| 4 | Anode (Color 2)   |

## Device Selection Guide

### Bi Color

| Part Number      | Color 1          | Color 2              |
|------------------|------------------|----------------------|
| HSMF-A201- xxxxx | GaP Red          | GaP Yellow Green     |
| HSMF-A202- xxxxx | GaP Red          | GaP Yellow           |
| HSMF-A203- xxxxx | GaP Red          | GaP Emerald Green    |
| HSMF-A204- xxxxx | GaP Orange       | GaP Yellow Green     |
| HSMF-A205- xxxxx | GaP Orange       | GaP Emerald Green    |
| HSMF-A206- xxxxx | GaP Yellow       | GaP Yellow Green     |
| HSMF-A211- xxxxx | AlGaAs Red       | GaP Yellow Green     |
| HSMF-A212- xxxxx | AlGaAs Red       | GaP Yellow           |
| HSMF-A222- xxxxx | AS AlInGaP Red   | AS AlInGaP Amber     |
| HSMF-A227- xxxxx | AS AlInGaP Red   | GaN Blue             |
| HSMF-A228- xxxxx | AS AlInGaP Amber | GaN Blue             |
| HSMF-A226- xxxxx | AS AlInGaP Amber | AlInGaP Yellow Green |

| Part Number     | Color 1                   |       |                             | Color 2                   |       |                             |
|-----------------|---------------------------|-------|-----------------------------|---------------------------|-------|-----------------------------|
|                 | Min. Iv @ 20 mA<br>Bin ID | (mcd) | Typical Iv @ 20 mA<br>(mcd) | Min. Iv @ 20 mA<br>Bin ID | (mcd) | Typical Iv @ 20 mA<br>(mcd) |
| HSMF-A201-A00J1 | K2                        | 8.0   | 16.0                        | L1                        | 10.0  | 20.0                        |
| HSMF-A202-A00J1 | K2                        | 8.0   | 16.0                        | K1                        | 6.3   | 12.0                        |
| HSMF-A203-A00J1 | K2                        | 8.0   | 16.0                        | J1                        | 4.0   | 8.0                         |
| HSMF-A204-A00J1 | K2                        | 8.0   | 16.0                        | L1                        | 10.0  | 20.0                        |
| HSMF-A205-A00J1 | K2                        | 8.0   | 16.0                        | J1                        | 4.0   | 8.0                         |
| HSMF-A206-A00J1 | K2                        | 8.0   | 16.0                        | L1                        | 10.0  | 20.0                        |
| HSMF-A211-A00J1 | L2                        | 12.5  | 25.0                        | L1                        | 10.0  | 20.0                        |
| HSMF-A212-A00J1 | L2                        | 12.5  | 25.0                        | K1                        | 6.3   | 12.0                        |
| HSMF-A222-A00J1 | P1                        | 40.0  | 80.0                        | P1                        | 40.0  | 80.0                        |
| HSMF-A227-A00J1 | P1                        | 40.0  | 80.0                        | J2                        | 5.0   | 10.0                        |
| HSMF-A228-A00J1 | P1                        | 40.0  | 80.0                        | J2                        | 5.0   | 10.0                        |
| HSMF-A226-A00J1 | P2                        | 49.0  | 100.0                       | M2                        | 20.0  | 60.0                        |

**Note:**

1. The luminous intensity Iv, is measured at the mechanical axis of the lamp package. The actual peak of the spatial radiation pattern may not be aligned with this axis.

**Tri Color**

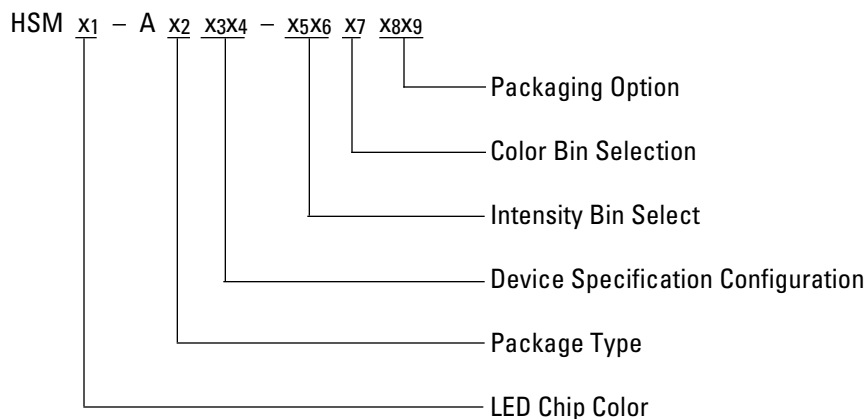
| Part Number     | Color 1               | Color 2          | Color 3    |
|-----------------|-----------------------|------------------|------------|
| HSMF-A301-xxxxx | GaP Red               | GaP Yellow Green | GaN Blue   |
| HSMF-A331-xxxxx | AS AlInGaP Red        | InGaN Green      | GaN Blue   |
| HSMF-A332-xxxxx | AS AlInGaP Red Orange | InGaN Green      | GaN Blue   |
| HSMF-A341-xxxxx | AS AlInGaP Red        | InGaN Green      | InGaN Blue |
| HSMF-A342-xxxxx | AS AlInGaP Red Orange | InGaN Green      | InGaN Blue |

| Part Number     | Color 1                   |       |                             | Color 2                   |       |                             | Color 3                   |       |                             |
|-----------------|---------------------------|-------|-----------------------------|---------------------------|-------|-----------------------------|---------------------------|-------|-----------------------------|
|                 | Min. Iv @ 20 mA<br>Bin ID | (mcd) | Typical Iv @ 20 mA<br>(mcd) | Min. Iv @ 20 mA<br>Bin ID | (mcd) | Typical Iv @ 20 mA<br>(mcd) | Min. Iv @ 20 mA<br>Bin ID | (mcd) | Typical Iv @ 20 mA<br>(mcd) |
| HSMF-A301-A00J1 | K2                        | 8.0   | 13.0                        | L2                        | 12.5  | 20.0                        | K2                        | 8.0   | 10.0                        |
| HSMF-A331-A00J1 | P1                        | 40.0  | 80.0                        | R1                        | 99.0  | 160.0                       | K2                        | 8.0   | 10.0                        |
| HSMF-A332-A00J1 | P1                        | 40.0  | 80.0                        | R1                        | 99.0  | 160.0                       | K2                        | 8.0   | 10.0                        |
| HSMF-A341-A00J1 | P1                        | 40.0  | 80.0                        | R1                        | 99.0  | 160.0                       | N1                        | 25.0  | 40.0                        |
| HSMF-A342-A00J1 | P1                        | 40.0  | 80.0                        | R1                        | 99.0  | 160.0                       | N1                        | 25.0  | 40.0                        |

**Note:**

1. The luminous intensity Iv, is measured at the mechanical axis of the lamp package. The actual peak of the spatial radiation pattern may not be aligned with this axis.

## Part Numbering System



## Absolute Maximum Ratings ( $T_A = 25^\circ\text{C}$ )

| Parameters                          | GaP             | AlGaAs | AS AlInGaP<br>Red, Amber | Yellow Green         | GaN/InGaN |
|-------------------------------------|-----------------|--------|--------------------------|----------------------|-----------|
| DC Forward Current <sup>[1]</sup>   | 30 mA           | 30 mA  | 30 mA <sup>[3,4]</sup>   | 20 mA <sup>[4]</sup> | 30 mA     |
| Peak Forward Current <sup>[2]</sup> | 100 mA          | 100 mA | 100 mA                   | 100 mA               | 100 mA    |
| Power Dissipation                   | 78 mW           | 78 mW  | 72 mW                    | 48 mW                | 120 mW    |
| Reverse Voltage                     | 5 V             |        |                          |                      |           |
| Junction Temperature                | 110°C           |        |                          |                      |           |
| Operating Temperature               | -55°C to +100°C |        |                          |                      |           |
| Storage Temperature                 | -55°C to +100°C |        |                          |                      |           |

### Notes:

- Derate linearly as shown in figure 4.
- Duty factor = 10%, Frequency = 1 kHz.
- Drive Current between 10 mA and 30 mA are recommended for best long term performance.
- Operation at current below 5 mA is not recommended.

**Optical Characteristics (T<sub>A</sub> = 25°C)**

| <b>Color</b>          | <b>Peak Wavelength<br/><math>\lambda_{\text{PEAK}}</math> (nm)<br/>Typ.</b> | <b>Dominant Wavelength<br/><math>\lambda_{\text{D}}</math> (nm)[1]<br/>Typ.</b> | <b>Viewing Angle<br/><math>2\theta_{1/2}</math> (Degrees)[2]<br/>Typ.</b> | <b>Luminous Efficacy <math>\eta_v</math><br/>(lm/W)[3]<br/>Typ.</b> | <b>Luminous Intensity/<br/>Total Flux<br/><math>I_v</math> (mcd) / <math>\Phi_v</math> (lm)<br/>Typ.</b> |
|-----------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| GaP Red               | 635                                                                         | 626                                                                             | 120                                                                       | 120                                                                 | 0.45                                                                                                     |
| AlGaAs Red            | 645                                                                         | 637                                                                             | 120                                                                       | 63                                                                  | 0.45                                                                                                     |
| AS AlInGaP Red        | 635                                                                         | 626                                                                             | 120                                                                       | 150                                                                 | 0.45                                                                                                     |
| AS AlInGaP Red Orange | 621                                                                         | 615                                                                             | 120                                                                       | 240                                                                 | 0.45                                                                                                     |
| GaP Orange            | 600                                                                         | 602                                                                             | 120                                                                       | 380                                                                 | 0.45                                                                                                     |
| AS AlInGaP Amber      | 592                                                                         | 590                                                                             | 120                                                                       | 480                                                                 | 0.45                                                                                                     |
| GaP Yellow            | 583                                                                         | 585                                                                             | 120                                                                       | 580                                                                 | 0.45                                                                                                     |
| AS AlInGaP Amber      | 592                                                                         | 590                                                                             | 120                                                                       | 480                                                                 | 0.45                                                                                                     |
| GaP Yellow Green      | 565                                                                         | 569                                                                             | 120                                                                       | 590                                                                 | 0.45                                                                                                     |
| GaP Emerald Green     | 558                                                                         | 560                                                                             | 120                                                                       | 650                                                                 | 0.45                                                                                                     |
| InGaN Green           | 523                                                                         | 525                                                                             | 120                                                                       | 500                                                                 | 0.45                                                                                                     |
| InGaN Blue            | 468                                                                         | 470                                                                             | 120                                                                       | 75                                                                  | 0.45                                                                                                     |
| GaN Blue              | 428                                                                         | 462                                                                             | 120                                                                       | 65                                                                  | 0.45                                                                                                     |
| AlInGaP Yellow Green  | 575                                                                         | 571                                                                             | 120                                                                       | 620                                                                 | 0.45                                                                                                     |

**Notes:**

1. The dominant wavelength,  $\lambda_{\text{D}}$ , is derived from the CIE Chromaticity Diagram and represents the color of the device.
2.  $\theta_{1/2}$  is the off-axis angle where the luminous intensity is 1/2 the peak intensity.
3. Radiant intensity,  $I_e$  in watts/steradian, may be calculated from the equation  $I_e = I_v / \eta_v$ , where  $I_v$  is the luminous intensity in candelas and  $\eta_v$  is the luminous efficacy in lumens/watt.

**Electrical Characteristics (T<sub>A</sub> = 25°C)**

| <b>Dice Technology</b> | <b>Forward Voltage<br/><math>V_F</math> (Volts) @ <math>I_F = 20\text{mA}</math></b> |             | <b>Reverse Voltage<br/><math>V_R</math> @ 100 <math>\mu\text{A}</math></b> | <b>Reverse Voltage<br/><math>V_R</math> @ 10 <math>\mu\text{A}</math></b> |
|------------------------|--------------------------------------------------------------------------------------|-------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------|
|                        | <b>Typ.</b>                                                                          | <b>Max.</b> | <b>Min.</b>                                                                | <b>Min.</b>                                                               |
| GaP                    | 2.2                                                                                  | 2.6         | 5                                                                          | -                                                                         |
| AS AlGaAs              | 1.9                                                                                  | 2.6         | 5                                                                          | -                                                                         |
| AS AlInGaP             | 1.9                                                                                  | 2.4         | 5                                                                          | -                                                                         |
| GaN Blue               | 3.9                                                                                  | 4.3         | -                                                                          | 5                                                                         |
| InGaN                  | 3.4                                                                                  | 4.05        | -                                                                          | 5                                                                         |

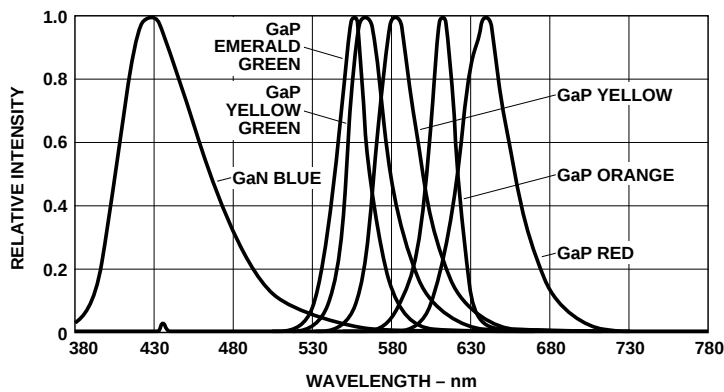
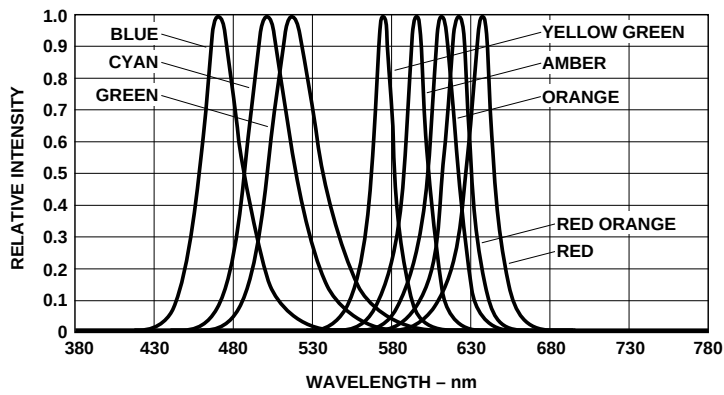


Figure 1. Relative intensity vs. wavelength.

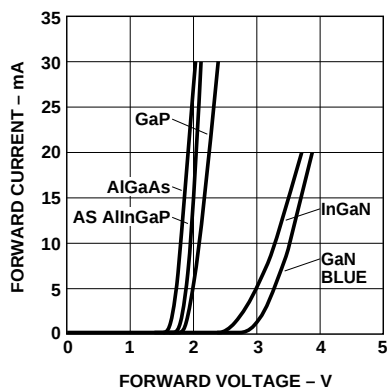


Figure 2. Forward current vs. forward voltage.

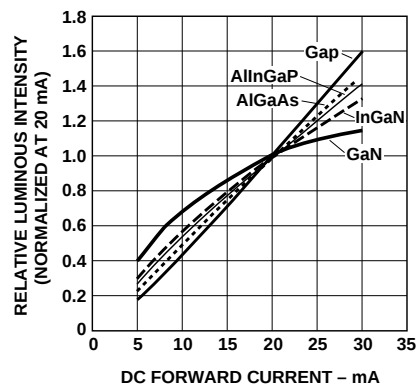


Figure 3. Relative intensity vs. forward voltage.

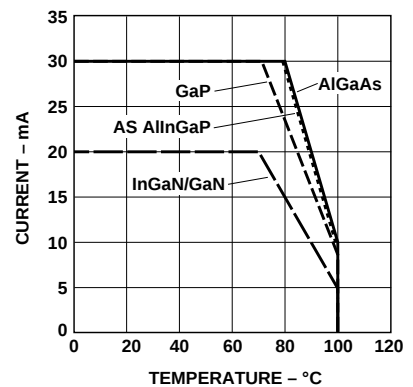


Figure 4a. Maximum forward current vs. ambient temperature. Derated based on  $T_{JMAX} = 110^{\circ}C$ ,  $R_{\theta JA} = 500^{\circ}C/W$  (1 chip on).

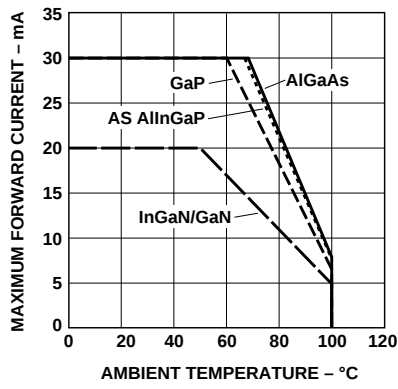


Figure 4b. Maximum forward current vs. ambient temperature. Derated based on  $T_{JMAX} = 110^{\circ}\text{C}$ ,  $R_{\theta JA} = 700^{\circ}\text{C/W}$  (3 chip on).

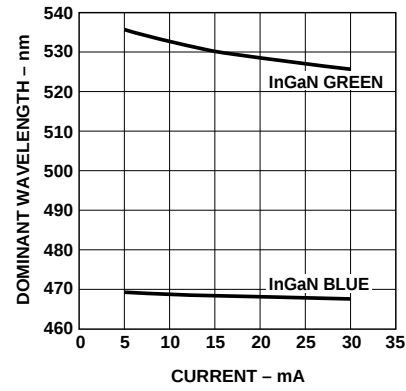


Figure 5. Dominant wavelength vs. forward current – InGaN.

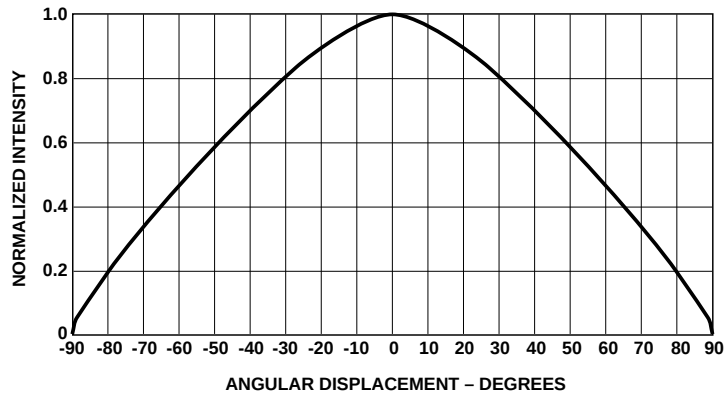


Figure 6. Radiation pattern.

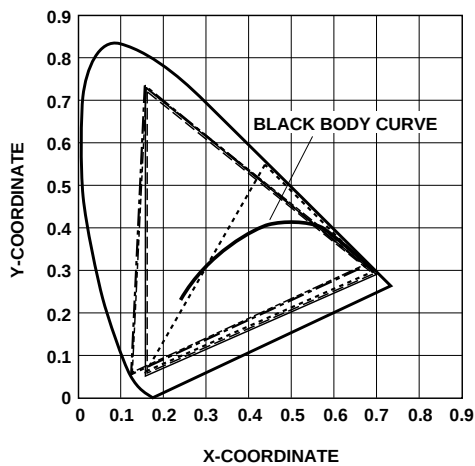


Figure 7. Chromaticity diagram for Tricolor.

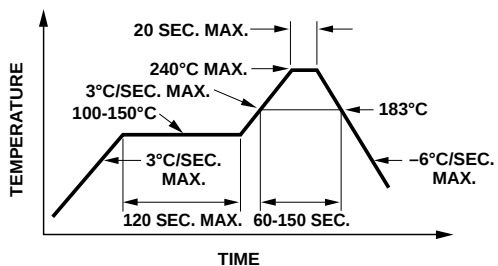


Figure 8. Recommended reflow soldering profile.

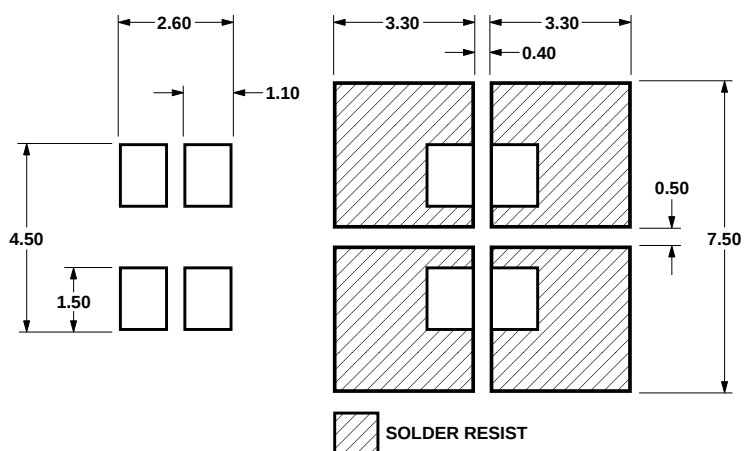


Figure 9. Recommended soldering pad pattern.

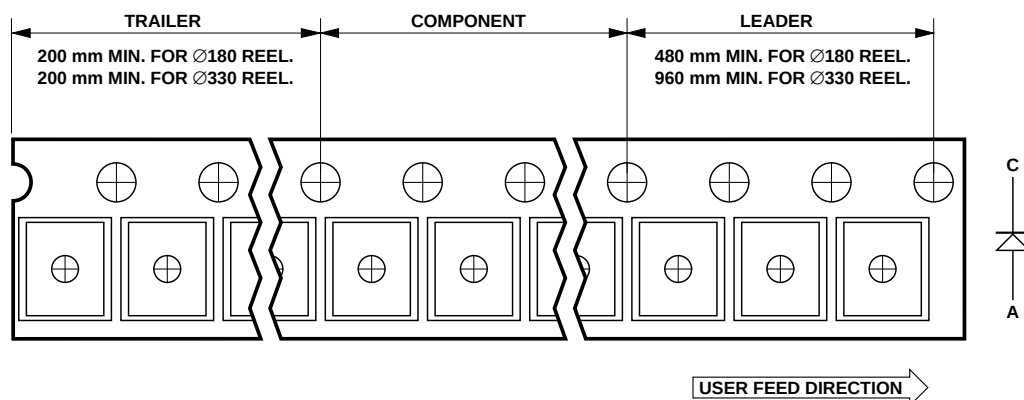


Figure 10. Tape leader and trailer dimension.

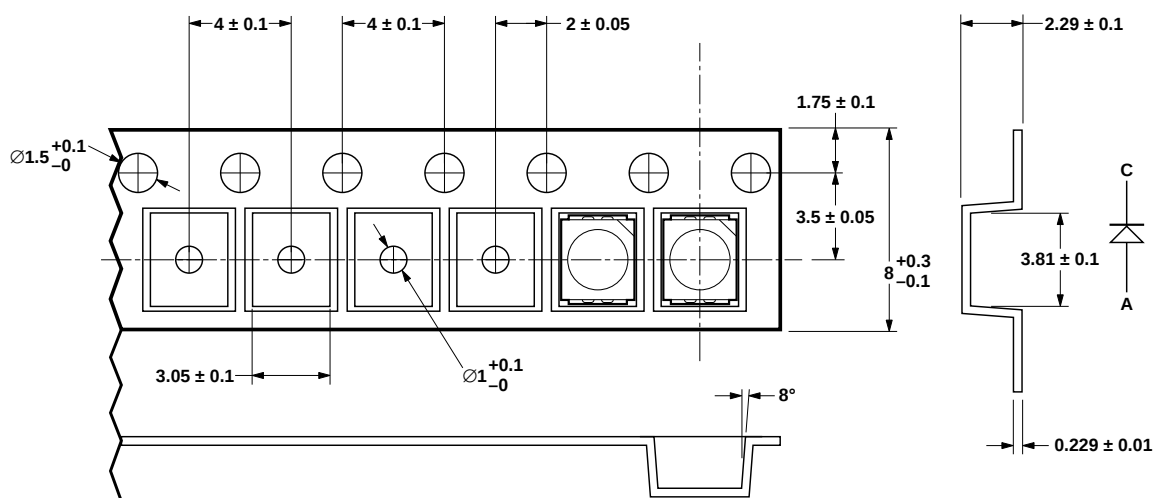


Figure 11. Tape leader and trailer dimension.

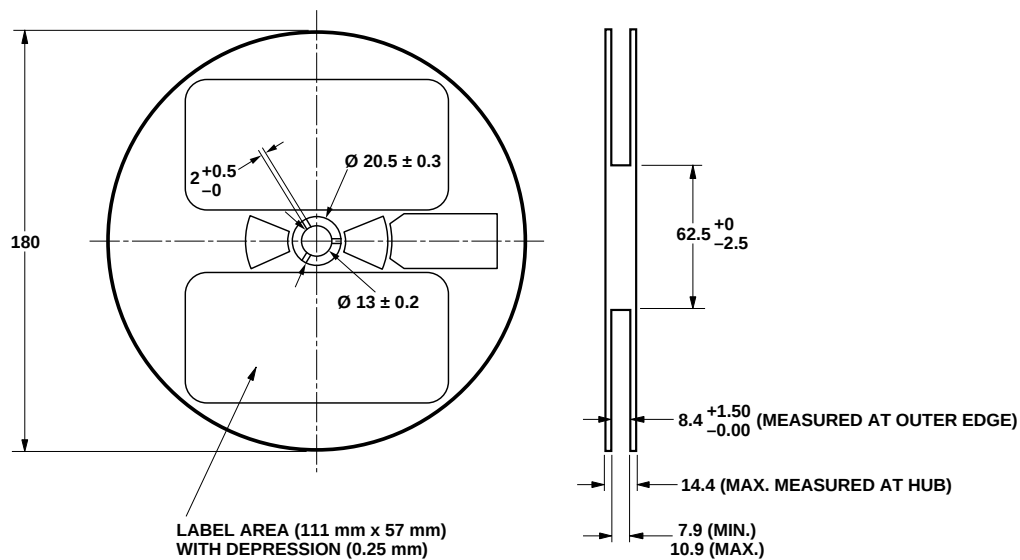


Figure 12. Reel dimension.

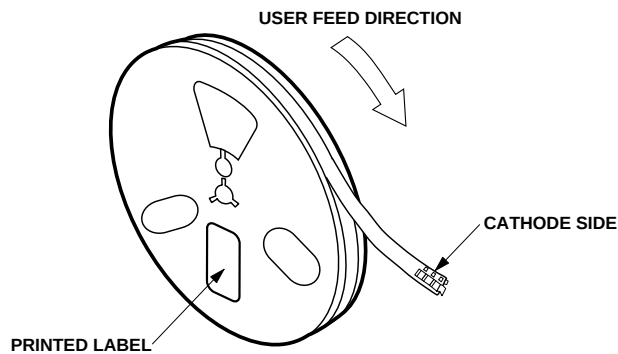


Figure 13. Reeling Orientation.

Storage Condition: 5 to 30°C @  
60% RH max.

Baking is required under the  
condition:

- the humidity indicator card  
becoming pink color
- the pack has been opened for  
more than 4 weeks

Baking recommended condition:  
60 ± 5°C for 20 hours.

This product is qualified as  
Moisture Sensitive JEDEC Level  
2A.

**Iv Bin Select (X5X6)**

Individual reel will contain parts from 1 half bin only.

| X5                    | Min. Iv Bin Selection              |                    |
|-----------------------|------------------------------------|--------------------|
| For                   |                                    |                    |
| HSMF-A201-xxxxxx      |                                    |                    |
| HSMF-A204-xxxxxx      |                                    |                    |
| HSMF-A206-xxxxxx      |                                    |                    |
| Minimum Intensity Bin |                                    |                    |
|                       | Color 1<br>(Red/Yellow/<br>Orange) | Color 2<br>(Green) |
| A                     | K2                                 | L1                 |
| B                     | K2                                 | L2                 |
| C                     | K2                                 | M1                 |
| D                     | K2                                 | M2                 |
| E                     | K2                                 | N1                 |
| F                     | L1                                 | L1                 |
| G                     | L1                                 | L2                 |
| H                     | L1                                 | M1                 |
| J                     | L1                                 | M2                 |
| K                     | L1                                 | N1                 |
| L                     | L2                                 | L1                 |
| M                     | L2                                 | L2                 |
| N                     | L2                                 | M1                 |
| P                     | L2                                 | M2                 |
| Q                     | L2                                 | N1                 |
| R                     | M1                                 | L1                 |
| S                     | M1                                 | L2                 |
| T                     | M1                                 | M1                 |
| U                     | M1                                 | M2                 |
| V                     | M1                                 | N1                 |
| W                     | M2                                 | L1                 |
| X                     | M2                                 | L2                 |
| Y                     | M2                                 | M1                 |
| Z                     | M2                                 | M2                 |
| 1                     | M2                                 | N1                 |

**For**  
**HSMF-A202-xxxxx**

|   | <b>Minimum Intensity Bin</b> |                             |
|---|------------------------------|-----------------------------|
|   | <b>Color 1<br/>(Red)</b>     | <b>Color 2<br/>(Yellow)</b> |
| A | K2                           | K1                          |
| B | K2                           | K2                          |
| C | K2                           | L1                          |
| D | K2                           | L2                          |
| E | K2                           | M1                          |
| F | L1                           | K1                          |
| G | L1                           | K2                          |
| H | L1                           | L1                          |
| J | L1                           | L2                          |
| K | L1                           | M1                          |
| L | L2                           | K1                          |
| M | L2                           | K2                          |
| N | L2                           | L1                          |
| P | L2                           | L2                          |
| Q | L2                           | M1                          |
| R | M1                           | K1                          |
| S | M1                           | K2                          |
| T | M1                           | L1                          |
| U | M1                           | L2                          |
| V | M1                           | M1                          |
| W | M2                           | K1                          |
| X | M2                           | K2                          |
| Y | M2                           | L1                          |
| Z | M2                           | L2                          |
| 1 | M2                           | M1                          |

**For**  
**HSMF-A203-xxxxx**  
**HSMF-A205-xxxxx**

|   | <b>Minimum Intensity Bin</b>    |                            |
|---|---------------------------------|----------------------------|
|   | <b>Color 1<br/>(Red/Orange)</b> | <b>Color 2<br/>(Green)</b> |
| A | K2                              | J1                         |
| B | K2                              | J2                         |
| C | K2                              | K1                         |
| D | K2                              | K2                         |
| E | K2                              | L1                         |
| F | L1                              | J1                         |
| G | L1                              | J2                         |
| H | L1                              | K1                         |
| J | L1                              | K2                         |
| K | L1                              | L1                         |
| L | L2                              | J1                         |
| M | L2                              | J2                         |
| N | L2                              | K1                         |
| P | L2                              | K2                         |
| Q | L2                              | L1                         |
| R | M1                              | J1                         |
| S | M1                              | J2                         |
| T | M1                              | K1                         |
| U | M1                              | K2                         |
| V | M1                              | L1                         |
| W | M2                              | J1                         |
| X | M2                              | J2                         |
| Y | M2                              | K1                         |
| Z | M2                              | K2                         |
| 1 | M2                              | L1                         |

| For<br>HSMF-A211-xxxxxx |                  |                    |
|-------------------------|------------------|--------------------|
| Minimum Intensity Bin   |                  |                    |
|                         | Color 1<br>(Red) | Color 2<br>(Green) |
| A                       | L2               | L1                 |
| B                       | L2               | L2                 |
| C                       | L2               | M1                 |
| D                       | L2               | M2                 |
| E                       | L2               | N1                 |
| F                       | M1               | L1                 |
| G                       | M1               | L2                 |
| H                       | M1               | M1                 |
| J                       | M1               | M2                 |
| K                       | M1               | N1                 |
| L                       | M2               | L1                 |
| M                       | M2               | L2                 |
| N                       | M2               | M1                 |
| P                       | M2               | M2                 |
| Q                       | M2               | N1                 |
| R                       | N1               | L1                 |
| S                       | N1               | L2                 |
| T                       | N1               | M1                 |
| U                       | N1               | M2                 |
| V                       | N1               | N1                 |
| W                       | N2               | L1                 |
| X                       | N2               | L2                 |
| Y                       | N2               | M1                 |
| Z                       | N2               | M2                 |
| 1                       | N2               | N1                 |

Note: 0 represents no maximum bin limit.

| For<br>HSMF-A212-xxxxxx |                  |                     |
|-------------------------|------------------|---------------------|
| Minimum Intensity Bin   |                  |                     |
|                         | Color 1<br>(Red) | Color 2<br>(Yellow) |
| A                       | L2               | K1                  |
| B                       | L2               | K2                  |
| C                       | L2               | L1                  |
| D                       | L2               | L2                  |
| E                       | L2               | M1                  |
| F                       | M1               | K1                  |
| G                       | M1               | K2                  |
| H                       | M1               | L1                  |
| J                       | M1               | L2                  |
| K                       | M1               | M1                  |
| L                       | M2               | K1                  |
| M                       | M2               | K2                  |
| N                       | M2               | L1                  |
| P                       | M2               | L2                  |
| Q                       | M2               | M1                  |
| R                       | N1               | K1                  |
| S                       | N1               | K2                  |
| T                       | N1               | L1                  |
| U                       | N1               | L2                  |
| V                       | N1               | M1                  |
| W                       | N2               | K1                  |
| X                       | N2               | K2                  |
| Y                       | N2               | L1                  |
| Z                       | N2               | L2                  |
| 1                       | N2               | M1                  |

| For<br>HSMF-A222-xxxxxx |                  |                    |
|-------------------------|------------------|--------------------|
| Minimum Intensity Bin   |                  |                    |
|                         | Color 1<br>(Red) | Color 2<br>(Amber) |
| A                       | P1               | P1                 |
| B                       | P1               | P2                 |
| C                       | P1               | Q1                 |
| D                       | P1               | Q2                 |
| E                       | P1               | R1                 |
| F                       | P2               | P1                 |
| G                       | P2               | P2                 |
| H                       | P2               | Q1                 |
| J                       | P2               | Q2                 |
| K                       | P2               | R1                 |
| L                       | Q1               | P1                 |
| M                       | Q1               | P2                 |
| N                       | Q1               | Q1                 |
| P                       | Q1               | Q2                 |
| Q                       | Q1               | R1                 |
| R                       | Q2               | P1                 |
| S                       | Q2               | P2                 |
| T                       | Q2               | Q1                 |
| U                       | Q2               | Q2                 |
| V                       | Q2               | R1                 |
| W                       | R1               | P1                 |
| X                       | R1               | P2                 |
| Y                       | R1               | Q1                 |
| Z                       | R1               | Q2                 |
| 1                       | R1               | R1                 |
| 2                       | R2               | P1                 |
| 3                       | R2               | P2                 |
| 4                       | R2               | Q1                 |
| 5                       | R2               | Q2                 |
| 6                       | R2               | R1                 |

| For<br>HSMF-A227-xxxxxx<br>HSMF-A228-xxxxxx |                        |                   |
|---------------------------------------------|------------------------|-------------------|
| Minimum Intensity Bin                       |                        |                   |
|                                             | Color 1<br>(Red/Amber) | Color 2<br>(Blue) |
| A                                           | P1                     | J2                |
| B                                           | P1                     | K1                |
| C                                           | P1                     | K2                |
| D                                           | P1                     | L1                |
| E                                           | P1                     | L2                |
| F                                           | P2                     | J2                |
| G                                           | P2                     | K1                |
| H                                           | P2                     | K2                |
| J                                           | P2                     | L1                |
| K                                           | P2                     | L2                |
| L                                           | Q1                     | J2                |
| M                                           | Q1                     | K1                |
| N                                           | Q1                     | K2                |
| P                                           | Q1                     | L1                |
| Q                                           | Q1                     | L2                |
| R                                           | Q2                     | J2                |
| S                                           | Q2                     | K1                |
| T                                           | Q2                     | K2                |
| U                                           | Q2                     | L1                |
| V                                           | Q2                     | L2                |
| W                                           | R1                     | J2                |
| X                                           | R1                     | K1                |
| Y                                           | R1                     | K2                |
| Z                                           | R1                     | L1                |
| 1                                           | R1                     | L2                |
| 2                                           | R2                     | J2                |
| 3                                           | R2                     | K1                |
| 4                                           | R2                     | K2                |
| 5                                           | R2                     | L1                |
| 6                                           | R2                     | L2                |

| For<br>HSMF-A331-xxxxxx<br>HSMF-A332-xxxxxx |                                |                    |                   |
|---------------------------------------------|--------------------------------|--------------------|-------------------|
| Minimum Intensity Bin                       |                                |                    |                   |
|                                             | Color 1<br>(Red/Red<br>Orange) | Color 2<br>(Green) | Color 3<br>(Blue) |
| A                                           | P1                             | R1                 | K2                |
| B                                           | P1                             | R1                 | L1                |
| C                                           | P1                             | R1                 | L2                |
| D                                           | P1                             | R2                 | K2                |
| E                                           | P1                             | R2                 | L1                |
| F                                           | P1                             | R2                 | L2                |
| G                                           | P1                             | S1                 | K2                |
| H                                           | P1                             | S1                 | L1                |
| J                                           | P1                             | S1                 | L2                |
| K                                           | P2                             | R1                 | K2                |
| L                                           | P2                             | R1                 | L1                |
| M                                           | P2                             | R1                 | L2                |
| N                                           | P2                             | R2                 | K2                |
| P                                           | P2                             | R2                 | L1                |
| Q                                           | P2                             | R2                 | L2                |
| R                                           | P2                             | S1                 | K2                |
| S                                           | P2                             | S1                 | L1                |
| T                                           | P2                             | S1                 | L2                |
| U                                           | Q1                             | R1                 | K2                |
| V                                           | Q1                             | R1                 | L1                |
| W                                           | Q1                             | R1                 | L2                |
| X                                           | Q1                             | R2                 | K2                |
| Y                                           | Q1                             | R2                 | L1                |
| Z                                           | Q1                             | R2                 | L2                |
| 1                                           | Q1                             | S1                 | K2                |
| 2                                           | Q1                             | S1                 | L1                |
| 3                                           | Q1                             | S1                 | L2                |
| 4                                           | Q2                             | R1                 | K2                |
| 5                                           | Q2                             | R1                 | L1                |
| 6                                           | Q2                             | R1                 | L2                |
| 7                                           | Q2                             | R2                 | K2                |
| 8                                           | Q2                             | R2                 | L1                |
| 9                                           | Q2                             | R2                 | L2                |

| For<br>HSMF-A341-xxxxxx<br>HSMF-A342-xxxxxx |                                |                    |                   |
|---------------------------------------------|--------------------------------|--------------------|-------------------|
| Minimum Intensity Bin                       |                                |                    |                   |
|                                             | Color 1<br>(Red/Red<br>Orange) | Color 2<br>(Green) | Color 3<br>(Blue) |
| A                                           | P1                             | R1                 | N1                |
| B                                           | P1                             | R1                 | N2                |
| C                                           | P1                             | R1                 | P1                |
| D                                           | P1                             | R2                 | N1                |
| E                                           | P1                             | R2                 | N2                |
| F                                           | P1                             | R2                 | P1                |
| G                                           | P1                             | S1                 | N1                |
| H                                           | P1                             | S1                 | N2                |
| J                                           | P1                             | S1                 | P1                |
| K                                           | P2                             | R1                 | N1                |
| L                                           | P2                             | R1                 | N2                |
| M                                           | P2                             | R1                 | P1                |
| N                                           | P2                             | R2                 | N1                |
| P                                           | P2                             | R2                 | N2                |
| Q                                           | P2                             | R2                 | P1                |
| R                                           | P2                             | S1                 | N1                |
| S                                           | P2                             | S1                 | N2                |
| T                                           | P2                             | S1                 | P1                |
| U                                           | Q1                             | R1                 | N1                |
| V                                           | Q1                             | R1                 | N2                |
| W                                           | Q1                             | R1                 | P1                |
| X                                           | Q1                             | R2                 | N1                |
| Y                                           | Q1                             | R2                 | N2                |
| Z                                           | Q1                             | R2                 | P1                |
| 1                                           | Q1                             | S1                 | N1                |
| 2                                           | Q1                             | S1                 | N2                |
| 3                                           | Q1                             | S1                 | P1                |
| 4                                           | Q2                             | R1                 | N1                |
| 5                                           | Q2                             | R1                 | N2                |
| 6                                           | Q2                             | R1                 | P1                |
| 7                                           | Q2                             | R2                 | N1                |
| 8                                           | Q2                             | R2                 | N2                |
| 9                                           | Q2                             | R2                 | P1                |

| X <sub>6</sub>         | Number of Half bins from X <sub>5</sub> |         |
|------------------------|-----------------------------------------|---------|
| For<br>HSMF-A2xx-xxxxx |                                         |         |
|                        | Color 1                                 | Color 2 |
| 0                      | 0                                       | 0       |
| A                      | 0                                       | 5       |
| B                      | 0                                       | 4       |
| C                      | 0                                       | 3       |
| D                      | 0                                       | 2       |
| E                      | 5                                       | 0       |
| F                      | 5                                       | 5       |
| G                      | 5                                       | 4       |
| H                      | 5                                       | 3       |
| J                      | 5                                       | 2       |
| K                      | 4                                       | 0       |
| L                      | 4                                       | 5       |
| M                      | 4                                       | 4       |
| N                      | 4                                       | 3       |
| P                      | 4                                       | 2       |
| Q                      | 3                                       | 0       |
| R                      | 3                                       | 5       |
| S                      | 3                                       | 4       |
| T                      | 3                                       | 3       |
| U                      | 3                                       | 2       |
| V                      | 2                                       | 0       |
| W                      | 2                                       | 5       |
| X                      | 2                                       | 4       |
| Y                      | 2                                       | 3       |
| Z                      | 2                                       | 2       |

Note: 0 represents no maximum bin limit.

| <b>For<br/>HSMF-A3xx-xxxxx</b> |                                         |                            |                           |
|--------------------------------|-----------------------------------------|----------------------------|---------------------------|
|                                | <b>Color 1<br/>(Red/Red<br/>Orange)</b> | <b>Color 2<br/>(Green)</b> | <b>Color 3<br/>(Blue)</b> |
| 0                              | 0                                       | 0                          | 0                         |
| A                              | 5                                       | 5                          | 5                         |
| B                              | 5                                       | 5                          | 4                         |
| C                              | 5                                       | 5                          | 3                         |
| D                              | 5                                       | 4                          | 5                         |
| E                              | 5                                       | 4                          | 4                         |
| F                              | 5                                       | 4                          | 3                         |
| G                              | 5                                       | 3                          | 5                         |
| H                              | 5                                       | 3                          | 4                         |
| J                              | 5                                       | 3                          | 3                         |
| K                              | 4                                       | 5                          | 5                         |
| L                              | 4                                       | 5                          | 4                         |
| M                              | 4                                       | 5                          | 3                         |
| N                              | 4                                       | 4                          | 5                         |
| P                              | 4                                       | 4                          | 4                         |
| Q                              | 4                                       | 4                          | 3                         |
| R                              | 4                                       | 3                          | 5                         |
| S                              | 4                                       | 3                          | 4                         |
| T                              | 4                                       | 3                          | 3                         |
| U                              | 3                                       | 5                          | 5                         |
| V                              | 3                                       | 5                          | 4                         |
| W                              | 3                                       | 5                          | 3                         |
| X                              | 3                                       | 4                          | 5                         |
| Y                              | 3                                       | 4                          | 4                         |
| Z                              | 3                                       | 4                          | 3                         |
| 1                              | 3                                       | 3                          | 5                         |
| 2                              | 3                                       | 3                          | 4                         |
| 3                              | 3                                       | 3                          | 3                         |

Note: 0 represents no maximum bin limit.

| <b>Intensity Bin Limits</b> |                   |                   |
|-----------------------------|-------------------|-------------------|
| <b>Bin ID</b>               | <b>Min. (mcd)</b> | <b>Max. (mcd)</b> |
| J1                          | 4.50              | 5.60              |
| J2                          | 5.60              | 7.20              |
| K1                          | 7.20              | 9.00              |
| K2                          | 9.00              | 11.20             |
| L1                          | 11.20             | 14.00             |
| L2                          | 14.00             | 18.00             |
| M1                          | 18.00             | 22.40             |
| M2                          | 22.40             | 28.50             |
| N1                          | 28.50             | 35.50             |
| N2                          | 35.50             | 45.00             |
| P1                          | 45.00             | 56.00             |
| P2                          | 56.00             | 71.50             |
| Q1                          | 71.50             | 90.00             |
| Q2                          | 90.00             | 112.50            |
| R1                          | 112.50            | 140.00            |
| R2                          | 140.00            | 180.00            |
| S1                          | 180.00            | 224.00            |
| S2                          | 224.00            | 285.00            |
| T1                          | 285.00            | 355.00            |
| T2                          | 355.00            | 450.00            |
| U1                          | 450.00            | 560.00            |
| U2                          | 560.00            | 715.00            |
| V1                          | 715.00            | 900.00            |
| V2                          | 900.00            | 1125.00           |

Tolerance of each bin limit =  $\pm 12\%$ .

**Color Bin Select (X7)**

Individual reel will contain parts from 1 full bin only.

| <b>X7 Color Bin Combinations</b>                                                                                                                  |                          |                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-----------------------------------------------------|
| <b>For</b><br><b>HSMF-A202-xxxxxx</b><br><b>HSMF-A203-xxxxxx</b><br><b>HSMF-A212-xxxxxx</b><br><b>HSMF-A222-xxxxxx</b><br><b>HSMF-A227-xxxxxx</b> |                          |                                                     |
|                                                                                                                                                   | <b>Color 1<br/>(Red)</b> | <b>Color 2<br/>(Emerald Green/<br/>Yellow/Blue)</b> |
| 0                                                                                                                                                 | 0                        | 0                                                   |
| A                                                                                                                                                 | 0                        | ABC                                                 |
| B                                                                                                                                                 | 0                        | ABCD                                                |
| C                                                                                                                                                 | 0                        | ABCDE                                               |
| D                                                                                                                                                 | 0                        | BCD                                                 |
| E                                                                                                                                                 | 0                        | BCDE                                                |
| F                                                                                                                                                 | 0                        | BCDEF                                               |
| G                                                                                                                                                 | 0                        | CDE                                                 |
| H                                                                                                                                                 | 0                        | DEF                                                 |
| J                                                                                                                                                 | 0                        | CDEF                                                |
| K                                                                                                                                                 | 0                        | AB                                                  |
| L                                                                                                                                                 | 0                        | BC                                                  |
| M                                                                                                                                                 | 0                        | CD                                                  |
| N                                                                                                                                                 | 0                        | DE                                                  |
| P                                                                                                                                                 | 0                        | EF                                                  |

Note: 0 represents full distribution.

**For**  
**HSMF-A201-xxxxxx**  
**HSMF-A211-xxxxxx**

|   | <b>Color 1<br/>(Red)</b> | <b>Color 2<br/>(Yellow Green)</b> |
|---|--------------------------|-----------------------------------|
| 0 | 0                        | 0                                 |
| A | 0                        | EFG                               |
| B | 0                        | FGH                               |
| C | 0                        | EF                                |
| D | 0                        | FG                                |
| E | 0                        | GH                                |

Note: 0 represents full distribution.

**For**  
**HSMF-A205-xxxxxx**  
**HSMF-A228-xxxxxx**

|   | <b>Color 1<br/>(Yellow/Amber/<br/>Orange)</b> | <b>Color 2<br/>(Emerald<br/>Green/Blue)</b> |
|---|-----------------------------------------------|---------------------------------------------|
| 0 | 0                                             | 0                                           |
| A | ABC                                           | ABC                                         |
| B | BCD                                           | ABC                                         |
| C | CDE                                           | ABC                                         |
| D | ABC                                           | BCD                                         |
| E | BCD                                           | BCD                                         |
| F | CDE                                           | BCD                                         |
| G | ABC                                           | CDE                                         |
| H | BCD                                           | CDE                                         |
| J | CDE                                           | CDE                                         |
| K | DEF                                           | ABC                                         |
| L | DEF                                           | BCD                                         |
| M | DEF                                           | CDE                                         |
| N | AB                                            | AB                                          |
| P | BC                                            | AB                                          |
| Q | CD                                            | AB                                          |
| R | DE                                            | AB                                          |
| S | AB                                            | BC                                          |
| T | BC                                            | BC                                          |
| U | CD                                            | BC                                          |
| V | DE                                            | BC                                          |
| W | AB                                            | CD                                          |
| X | BC                                            | CD                                          |
| Y | CD                                            | CD                                          |
| Z | DE                                            | CD                                          |
| 1 | AB                                            | DE                                          |
| 2 | BC                                            | DE                                          |
| 3 | CD                                            | DE                                          |
| 4 | DE                                            | DE                                          |
| 5 | EF                                            | AB                                          |
| 6 | EF                                            | BC                                          |
| 7 | EF                                            | CD                                          |

Note: 0 represents full distribution.

**For**  
**HSMF-A204-xxxxxx**  
**HSMF-A206-xxxxxx**

|   | <b>Color 1<br/>(Yellow/<br/>Amber/<br/>Orange)</b> | <b>Color 2<br/>(Yellow Green)</b> |
|---|----------------------------------------------------|-----------------------------------|
| 0 | 0                                                  | 0                                 |
| A | ABC                                                | EFG                               |
| B | BCD                                                | EFG                               |
| C | CDE                                                | EFG                               |
| D | DEF                                                | EFG                               |
| E | ABC                                                | FGH                               |
| F | BCD                                                | FGH                               |
| G | CDE                                                | FGH                               |
| H | DEF                                                | FGH                               |
| J | AB                                                 | EF                                |
| K | BC                                                 | EF                                |
| L | CD                                                 | EF                                |
| M | DE                                                 | EF                                |
| N | EF                                                 | EF                                |
| P | AB                                                 | FG                                |
| Q | BC                                                 | FG                                |
| R | CD                                                 | FG                                |
| S | DE                                                 | FG                                |
| T | EF                                                 | FG                                |
| U | AB                                                 | GH                                |
| V | BC                                                 | GH                                |
| W | CD                                                 | GH                                |
| X | DE                                                 | GH                                |
| Y | EF                                                 | GH                                |

Note: 0 represents full distribution.

| For<br>HSMF-A3xx-xxxxx |         |         |         |
|------------------------|---------|---------|---------|
|                        | Color 1 | Color 2 | Color 3 |
| 0                      | 0       | 0       | 0       |
| A                      | 0       | 0       | ABC     |
| B                      | 0       | 0       | BCD     |
| C                      | 0       | 0       | AB      |
| D                      | 0       | 0       | BC      |
| E                      | 0       | 0       | CD      |
| F                      | 0       | ABC     | 0       |
| G                      | 0       | ABC     | ABC     |
| H                      | 0       | ABC     | BCD     |
| J                      | 0       | ABC     | AB      |
| K                      | 0       | ABC     | BC      |
| L                      | 0       | ABC     | CD      |
| M                      | 0       | BCD     | 0       |
| N                      | 0       | BCD     | ABC     |
| P                      | 0       | BCD     | BCD     |
| Q                      | 0       | BCD     | AB      |
| R                      | 0       | BCD     | BC      |
| S                      | 0       | BCD     | CD      |
| T                      | 0       | AB      | ABC     |
| U                      | 0       | AB      | BCD     |
| V                      | 0       | AB      | AB      |
| W                      | 0       | AB      | BC      |
| X                      | 0       | AB      | CD      |
| Y                      | 0       | BC      | ABC     |
| Z                      | 0       | BC      | BCD     |
| 1                      | 0       | BC      | AB      |
| 2                      | 0       | BC      | BC      |
| 3                      | 0       | BC      | CD      |
| 4                      | 0       | CD      | ABC     |
| 5                      | 0       | CD      | BCD     |
| 6                      | 0       | CD      | AB      |
| 7                      | 0       | CD      | BC      |
| 8                      | 0       | CD      | CD      |

Note: 0 represents full distribution.

#### Color Bin Limits

| Blue | Min. (nm) | Max. (nm) |
|------|-----------|-----------|
| A    | 460.0     | 465.0     |
| B    | 465.0     | 470.0     |
| C    | 470.0     | 475.0     |
| D    | 475.0     | 480.0     |

| Green | Min. (nm) | Max. (nm) |
|-------|-----------|-----------|
| A     | 515.0     | 520.0     |
| B     | 520.0     | 525.0     |
| C     | 525.0     | 530.0     |
| D     | 530.0     | 535.0     |

| Emerald Green | Min. (nm) | Max. (nm) |
|---------------|-----------|-----------|
| A             | 552.5     | 555.5     |
| B             | 555.5     | 558.5     |
| C             | 558.5     | 561.5     |
| D             | 561.5     | 564.5     |

| Yellow Green | Min. (nm) | Max. (nm) |
|--------------|-----------|-----------|
| E            | 564.5     | 567.5     |
| F            | 567.5     | 570.5     |
| G            | 570.5     | 573.5     |
| H            | 573.5     | 576.5     |

#### Packaging Option (X8X9)

| X8X9 |                                            |
|------|--------------------------------------------|
| J1   | 20 mA test current, Top Mount, 7 inch Reel |

| Amber/<br>Yellow | Min. (nm) | Max. (nm) |
|------------------|-----------|-----------|
| A                | 582.0     | 584.5     |
| B                | 584.5     | 587.0     |
| C                | 587.0     | 589.5     |
| D                | 589.5     | 592.0     |
| E                | 592.0     | 594.5     |
| F                | 594.5     | 597.0     |

| Orange | Min. (nm) | Max. (nm) |
|--------|-----------|-----------|
| A      | 597.0     | 600.0     |
| B      | 600.0     | 603.0     |
| C      | 603.0     | 606.0     |
| D      | 606.0     | 609.0     |
| E      | 609.0     | 612.0     |

| Red Orange | Min. (nm) | Max. (nm) |
|------------|-----------|-----------|
| A          | 611.0     | 616.0     |
| B          | 616.0     | 620.0     |

| Red               | Min. (nm) | Max. (nm) |
|-------------------|-----------|-----------|
| Full Distribution |           |           |

Tolerance of each bin limit =  $\pm 1$  nm.

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