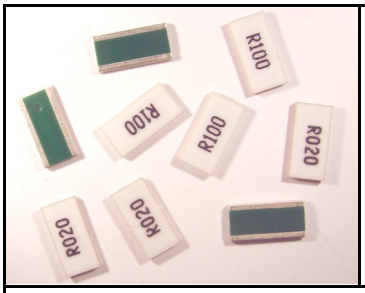
Thin Film Technology Corp.

Product Family: 2-Terminal Low Ohm Current Sense Resistors

Part Number Series: WKL Series



Construction:

- High purity alumina substrate
- Metal foil resistive element
- Epoxy-resin overcoat
- Non-wrapped electrodes
- Sn100 terminations
- RoHS compliant and Pb free
- Inherently anti-sulfur

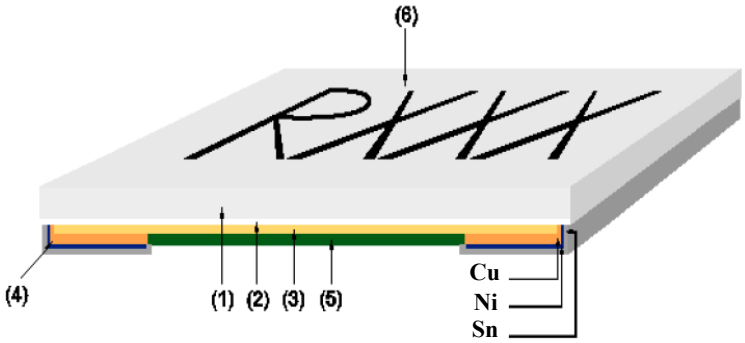
Features:

- Resistances from to 1mΩ~700mΩ
- TCR's down to ±50ppm/°C
- Optimal linearity in I/V conversion
- Short and long side electrode styles available
- Moisture sensitivity level = 1
- AEC-Q200 qualified

Description:

These low ohm current sense resistors are designed for tight resistance tolerance, low noise, long-term stability and high heat dissipation capability in a small package. This series is ideal for use in power management modules, motor control circuits and automotive applications. This series varies from the WEL series as it has non-wrapped electrodes.

Product Construction:



Number	Description
1	Substrate (alumina ceramic)
2	Adhesion layer (epoxy)
3	Resistive element (Cu alloy foil)
4	Terminal electrodes (Sn, Ni, Cu)
5	Protective coating (flame-retardant epoxy)
6	Marking* (flame-retardant epoxy)

***** Note: Marking is 2 digits (XX) for 0603 case size, 3 digits (XXX) for 0805 and 0508 case sizes, and 4 digits (RXXX) for all other case sizes.

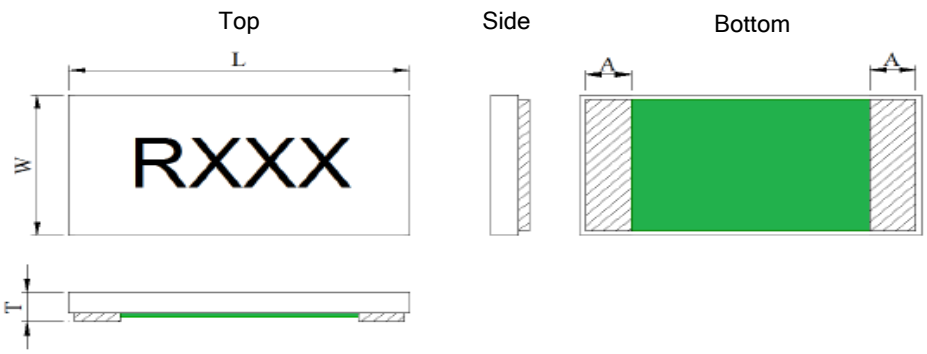
Part Numbering: Ex: WKL0508MR010F-T5

Series Name	English Size (Metric Size)	Material Code	Resistance Value	Resistance Tolerance	Automotive Grade	T&R Packaging Quantity
WKL	(Refer to "type" in the electrical tables)	**M**	Ex. **R010** = 10mΩ **R100** =100mΩ (Refer to electrical tables)	**D** = ±0.5%* **F** = ±1.0%	**A** = AEC-Q200 Leave Blank for non AEC-Q200	**-T1** = 1,000 **-T2** = 2,000 **-T4** = 4,000 **-T5** = 5,000 (Refer to electrical tables)

* Note: ±0.5% (D) tolerance is not available for all resistance values. See electrical specifications table.

Product Dimensions:

Type A: Short Electrode

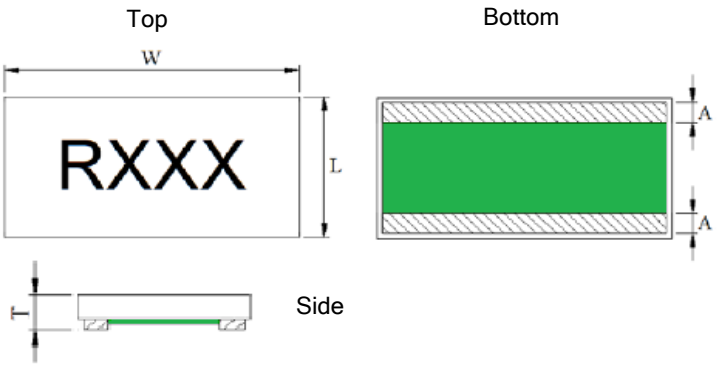


All dimensions are in inches, mm in parentheses.

Dimension (Metric)	Electrode Type	Resistance Range	L	W	A	T
WKL0603M (1608)	A	5mΩ	0.063 ±0.008 (1.60 ±0.20)	0.031 ±0.008 (0.80 ±0.20)	0.014 ±0.008 (0.35 ±0.20)	0.024 ±0.008 (0.60 ±0.20)
		6mΩ ~ 100mΩ			0.010 ±0.008 (0.25 ±0.20)	
WKL0805M (2012)	A	3mΩ	0.079 ±0.008 (2.00 ±0.20)	0.050 ±0.008 (1.25 ±0.20)	0.020 ±0.008 (0.50 ±0.20)	0.024 ±0.008 (0.60 ±0.20)
		4mΩ ~ 500mΩ			0.014 ±0.008 (0.35 ±0.20)	
WKL1206M (3216)	A	3mΩ	0.126 ±0.008 (3.20 ±0.20)	0.063 ±0.008 (1.60 ±0.20)	0.041 ±0.008 (1.05 ±0.20)	0.024 ±0.008 (0.60 ±0.20)
		4mΩ ~ 700mΩ			0.021 ±0.008 (0.53 ±0.20)	
WKL2010M (5025)	A	2mΩ ~ 3mΩ	0.197 ±0.008 (5.00 ±0.20)	0.098 ±0.008 (2.50 ±0.20)	0.077 ±0.012 (1.95 ±0.30)	0.024 ±0.008 (0.60 ±0.20)
		4mΩ ~ 700mΩ			0.022 ±0.012 (0.55 ±0.30)	
WKL2512M (6432)	A	2mΩ	0.248 ±0.012 (6.30 ±0.30)	0.122 ±0.012 (3.10 ±0.30)	0.104 ±0.008 (2.65 ±0.20)	0.024 ±0.008 (0.60 ±0.20)
		3mΩ			0.096 ±0.008 (2.45 ±0.20)	
		4mΩ ~ 700mΩ			0.035 ±0.008 (0.90 ±0.20)	
WKL4320M (11050)	A	2mΩ	0.433 ±0.012 (11.0 ±0.30)	0.197 ±0.012 (5.00 ±0.30)	0.187 ±0.012 (4.75 ±0.30)	0.024 ±0.008 (0.60 ±0.20)
		3mΩ			0.173 ±0.012 (4.40 ±0.30)	
		4mΩ ~ 100mΩ			0.087 ±0.012 (2.21 ±0.30)	
WKL4527M (11470)	A	2mΩ	0.453 ±0.040 (11.5 ±1.00)	0.276 ±0.040 (7.00 ±1.00)	0.191 ±0.016 (4.85 ±0.40)	0.024 ±0.012 (0.60 ±0.30)
		3mΩ ~ 100mΩ			0.100 ±0.016 (2.55 ±0.40)	

Product Dimensions (Cont.):

Type B: Long Electrode



All dimensions are in inches, mm in parentheses.

Dimension (Metric)	Electrode Type	Resistance Range	L	W	A	T
WKL0508M (1220)	B	1mΩ ~ 100mΩ	0.049 ±0.008 (1.25 ±0.20)	0.079 ±0.008 (2.00 ±0.20)	0.011 ±0.008 (0.28 ±0.20)	0.024 ±0.008 (0.60 ±0.20)
WKL0612M (1632)	B	1mΩ	0.063 ±0.008 (1.60 ±0.20)	0.126 ±0.008 (3.20 ±0.20)	0.016 ±0.012 (0.40 ±0.30)	0.024 ±0.008 (0.60 ±0.20)
		2mΩ ~ 100mΩ			0.010 ±0.008 (0.25 ±0.20)	
WKL0815M (2040)	B	1mΩ ~ 100mΩ	0.083 ±0.008 (2.10 ±0.20)	0.146 ±0.008 (3.70 ±0.20)	0.018 ±0.008 (0.46 ±0.20)	0.024 ±0.008 (0.60 ±0.20)
WKL1020M (2550)	B	1mΩ ~ 100mΩ	0.098 ±0.008 (2.50 ±0.20)	0.197 ±0.008 (5.00 ±0.20)	0.020 ±0.008 (0.50 ±0.20)	0.024 ±0.008 (0.60 ±0.20)
WKL1225M (3264)	B	1mΩ ~ 100mΩ	0.122 ±0.012 (3.10 ±0.30)	0.248 ±0.012 (6.30 ±0.30)	0.018 ±0.008 (0.45 ±0.20)	0.024 ±0.008 (0.60 ±0.20)
WKL0830M (2276)	B	1mΩ ~ 100mΩ	0.098 ±0.012 (2.50 ±0.30)	0.295 ±0.012 (7.50 ±0.30)	0.022 ±0.012 (0.55 ±0.30)	0.024 ±0.008 (0.60 ±0.20)
WKL1530M (3876)	B	1mΩ ~ 100mΩ	0.150 ±0.012 (3.80 ±0.30)	0.299 ±0.012 (7.60 ±0.30)	0.022 ±0.012 (0.55 ±0.30)	0.024 ±0.008 (0.60 ±0.20)
WKL1836M (4590)	B	1mΩ ~ 100mΩ	0.177 ±0.012 (4.50 ±0.30)	0.354 ±0.012 (9.00 ±0.30)	0.026 ±0.012 (0.65 ±0.30)	0.024 ±0.008 (0.60 ±0.20)
WKL2043M (05110)	B	1mΩ ~ 100mΩ	0.197 ±0.012 (5.00 ±0.30)	0.433 ±0.016 (11.0 ±0.40)	0.030 ±0.012 (0.75 ±0.30)	0.024 ±0.008 (0.60 ±0.20)

Electrical Specifications:

Type		WKL0603		WKL0805		WKL1206	
Electrode Style		Type “A” - Short Side Electrode					
Metric Size		1608		2012		3216	
Power Rating		1/2W		3/4W		1W	
Resistance Tolerance % (code)	±0.5(D)	-	10mΩ ~ 100mΩ	-	10mΩ ~ 500mΩ	-	10mΩ ~ 700mΩ
	±1.0(F)	5mΩ ~ 9mΩ		3mΩ ~ 9mΩ		3mΩ ~ 9mΩ	
Resistance Offering		1mΩ steps					
TCR ±ppm/°C		100	50	100	50	100	50
Operating Temp. Range		-55°C ~ +155°C					
Rated Voltage		√(Power x Resistance)					
Packaging		5,000 pcs/reel					

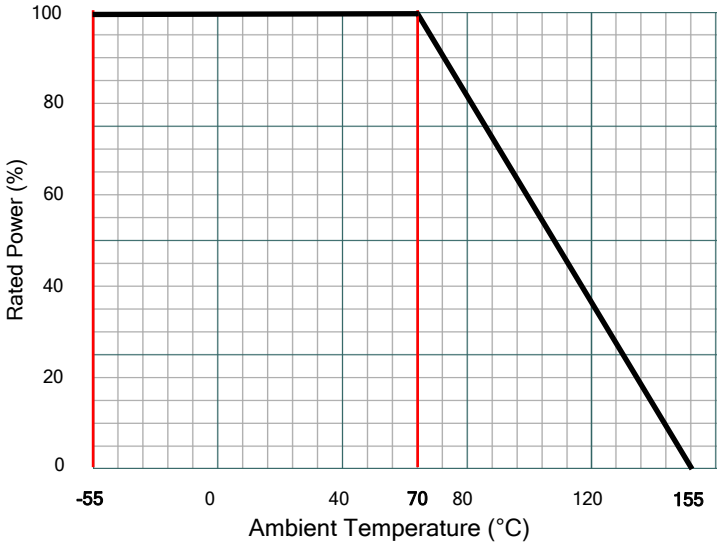
Electrical Specifications (Cont.):

Type		WKL2010		WKL2512		WKL4320		WKL4527	
Electrode Style		Type “A” - Short Side Electrode							
Metric Size		5025		6432		11050		11470	
Power Rating		1.5W		2W		3W		4W	
Resistance Tolerance % (code)	±0.5(D)	-	10mΩ ~ 700mΩ	-	10mΩ ~ 700mΩ	-	10mΩ ~ 100mΩ	-	10mΩ ~ 100mΩ
	±1.0(F)	2mΩ ~ 9mΩ		2mΩ~9mΩ		2mΩ ~ 9mΩ		2mΩ ~ 9mΩ	
Resistance Offering		1mΩ steps							
TCR ±ppm/°C		100	50	100	50	100	50	100	50
Operating Temp. Range		-55°C ~ +155°C							
Rated Voltage		√(Power x Resistance)							
Packaging		4,000 pcs/reel				2,000 pcs/reel		1,000 pcs/reel	

Type		WKL0508		WKL0612		WKL0815		WKL1020		WKL1225	
Electrode Style		Type “B” - Long Side Electrode									
Metric Size		1220		1632		2040		2550		3264	
Power Rating		1W		1.5W		2W				3W	
Resistance Tolerance % (code)	±0.5(D)	-	10mΩ ~ 100mΩ	-	10mΩ ~ 100mΩ	-	10mΩ ~ 100mΩ	-	10mΩ~ 100mΩ	-	10mΩ~ 100mΩ
	±1.0(F)	1mΩ ~ 9mΩ		1mΩ ~ 9mΩ		1mΩ ~ 9mΩ		1mΩ ~ 9mΩ		1mΩ ~ 9mΩ	
Resistance Offering		1mΩ steps									
TCR ±ppm/°C		100	50	100	50	100	50	100	50	100	50
Operating Temp. Range		-55°C ~ +155°C									
Rated Voltage		√(Power x Resistance)									
Packaging		5,000 pcs/reel				4,000 pcs/reel					

Type		WKL0830		WKL1530		WKL1836		WKL2043	
Electrode Style		Type “B” - Long Side Electrode							
Metric Size		2276		3876		4590		05110	
Power Rating		3W		4W				5W	
Resistance Tolerance % (code)	±0.5(D)	-	10mΩ ~ 100mΩ	-	10mΩ ~ 100mΩ	-	10mΩ ~ 100mΩ	-	10mΩ ~ 100mΩ
	±1.0(F)	1mΩ ~ 9mΩ		1mΩ ~ 9mΩ		1mΩ ~ 9mΩ		1mΩ ~ 9mΩ	
Resistance Offering		1mΩ steps							
TCR ±ppm/°C		100	50	100	50	100	50	100	50
Operating Temp. Range		-55°C ~ +155°C							
Rated Voltage		√(Power x Resistance)							
Packaging		4,000 pcs/reel		2,000 pcs/reel					

Power Derating Curve:



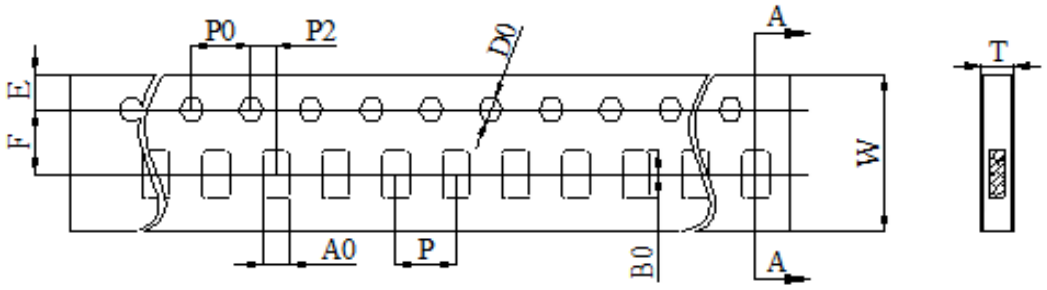
Reliability Specifications:

Test	Procedure	Specification
Short Time Overload IEC60115-1 4.13	P = 2.5PR; T = 25 ±2°C, t = 5 seconds	±(1.0%+0.5mΩ)
Load Life IEC60115-1 4.25	T = 70°C ±2°C Vtest = Vmax; t = 90 mins "ON" and 30 mins "OFF" Test period: 1,000 hours	±(2.0%+0.5mΩ)
Temperature Cycle (Thermal Shock) IEC60115-1 4.19	Repeat 100 cycles as follows: -55 ±3°C (30 min.) / +155 ±3°C (30 min.)	±(1.0%+0.5mΩ)
Resistance To Solder Heat IEC60115-1 4.18	Through Reflow, parts are subjected to 3 reflow cycles	±(1.0%+0.5mΩ)
Mechanical Shock IEC60115-1 4.21	A = 100G, t = 6ms	±(1.0%+0.5mΩ)
High Temperature Exposure IEC60115-1 4.25	T = +155 ±2°C; t = 1000h	±(1.0%+0.5mΩ)
Low Temperature Storage IEC60115-1 4.25	T = -55° ±2°C; t = 1000h	±(1.0%+0.5mΩ)
Moisture Load Life IEC60115-1 4.25	Vtest = Vmax; T = 60 ±2°C; RG = 95%; t = 90 mins "ON", 30 mins "OFF", 1000h	±(2.0%+0.5mΩ)
Solderability IEC60115-1 4.17	Dip into solder at T = 245 ±5°C, t = 3 ±1 second	The covered area >95%
Substrate Bending IEC60115-1 4.33	Span between fulcrums: 90mm, Bend Width: 2mm Test Board: Glass-epoxy board Thickness = 1.6mm	±(1.0%+0.5mΩ)

AEC-Q200 Specifications:

Test	Procedure	Specifications
Biased Humidity MIL-STD-202 Method 103	Test conditions: 85°C and 85% RH 10% of rated power Test period: 1,000 hours	±(1.0% +0.5mΩ)
Load Life (Operational Life) MIL-STD-202 Method 108	Test temperature: 125 ±3°C Applied voltage: rated power (derated power will be required if temp exceeds the derating point of the part) Test period: 1,000 hours	±(1.0% +0.5mΩ)
Resistance to Solvents MIL-STD-202 Method 215	3 minute soak 2-3 ounce force 10 strokes/repetition 3 repetitions	±(1.0% +0.5mΩ)
Vibration MIL-STD-202 Method 204	Frequency: 10-2,000Hz Acceleration: 5G Test duration: 20 minutes, 12 cycles	±(1.0% +0.5mΩ)
Resistance to Soldering Heat MIL-STD-202 Method 210	Condition B (Solder dip, no pre-heat) 260 ±5°C	±(1.0% +0.5mΩ)
ESD AEC-Q200-002	HBM, 100pF, 1.5kΩ Repetition: 5 times	±(1.0% +0.5mΩ)
Flammability UL-94	V-0 or V-1 are acceptable Electrical test not required	UL-94
Board Flex AEC-Q200-005	90mm span between fulcrums 2mm bend 60 seconds minimum holding time	±(1.0% +0.5mΩ)
Terminal Strength (SMD) AEC-Q200-006	Force of 17.7N 60 seconds	±(1.0% +0.5mΩ)
Flame Retardance AEC-Q200-001	Mounted parts subjected to voltages from 9.0 to 32.0 VDC (current clamped up to 500A) in 1.0 VDC increments. Voltage applied for 1 hour minimum or until failure occurs.	AEC-Q200-001

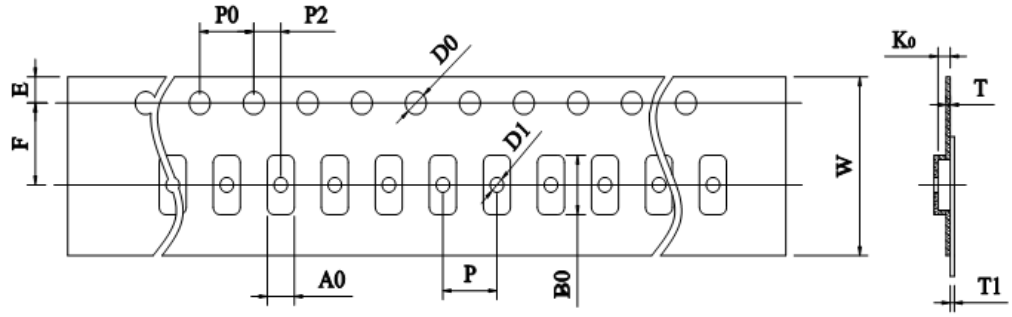
Paper Tape Dimensions:



All dimensions in mm.

Size	W	P0	P	P2	A0	B0	D0	F	E	T
0603	8.00 ±0.30	4.00 ±0.10	4.00 ±0.10	2.00 ±0.10	0.98 ±0.10	1.85 ±0.10	1.50 ±0.10	3.50 ±0.10	1.75 ±0.10	0.75 ±0.10
0805	8.00 ±0.30	4.00 ±0.10	4.00 ±0.10	2.00 ±0.10	1.55 ±0.10	2.30 ±0.10	1.50 ±0.10	3.50 ±0.10	1.75 ±0.10	0.75 ±0.10
1206	8.00 ±0.30	4.00 ±0.10	4.00 ±0.10	2.00 ±0.10	1.90 ±0.20	3.50 ±0.20	1.50 ±0.10	3.50 ±0.10	1.75 ±0.10	0.75 ±0.10
0508	8.00 ±0.30	4.00 ±0.10	4.00 ±0.10	2.00 ±0.10	1.55 ±0.10	2.30 ±0.10	1.50 ±0.10	3.50 ±0.10	1.75 ±0.10	0.75 ±0.10
0612	8.00 ±0.30	4.00 ±0.10	4.00 ±0.10	2.00 ±0.10	1.90 ±0.20	3.50 ±0.20	1.50 ±0.10	3.50 ±0.10	1.75 ±0.10	0.75 ±0.10

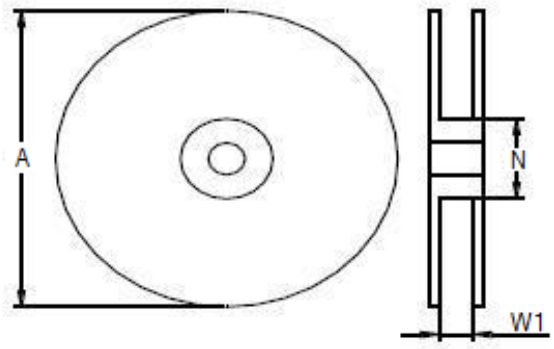
Plastic Tape Dimensions:



All dimensions in mm.

Size	W	P0	P	P2	A0	B0	D0	F	E	T	T1	K0
2010	12.0 ±0.30	4.00 ±0.10	4.00 ±0.10	2.00 ±0.10	2.85 ±0.20	5.45 ±0.20	1.50 ±0.10	5.50 ±0.10	1.75 ±0.10	0.25 ±0.10	Max 0.10	0.80 ±0.20
2512	12.0 ±0.30	4.00 ±0.10	4.00 ±0.10	2.00 ±0.10	3.40 ±0.20	6.75 ±0.20	1.50 ±0.10	5.50 ±0.10	1.75 ±0.10	0.25 ±0.10	Max 0.10	1.00 ±0.20
4527	24.0 ±0.30	4.00 ±0.10	12.0 ±0.10	2.00 ±0.10	7.50 ±0.20	12.0 ±0.20	1.50 ±0.10	11.5 ±0.10	1.75 ±0.10	0.30 ±0.10	Max 0.10	0.90 ±0.20
0815	12.0 ±0.40	4.00 ±0.10	4.00 ±0.10	2.00 ±0.10	2.30 ±0.20	4.10 ±0.20	1.50 ±0.10	5.50 ±0.10	1.75 ±0.10	0.25 ±0.10	Max 0.10	0.75 ±0.20
1020	12.0 ±0.30	4.00 ±0.10	4.00 ±0.10	2.00 ±0.10	2.85 ±0.20	5.45 ±0.20	1.50 ±0.10	5.50 ±0.10	1.75 ±0.10	0.25 ±0.10	Max 0.10	0.80 ±0.20
1225	12.0 ±0.30	4.00 ±0.10	4.00 ±0.10	2.00 ±0.10	3.40 ±0.20	6.75 ±0.20	1.50 ±0.10	5.50 ±0.10	1.75 ±0.10	0.25 ±0.10	Max 0.10	1.00 ±0.20
0830	16.0 ±0.30	4.00 ±0.10	4.00 ±0.10	2.00 ±0.10	2.80 ±0.20	8.00 ±0.20	1.50 ±0.10	7.50 ±0.10	1.75 ±0.10	0.30 ±0.10	Max 0.10	0.80 ±0.20
1530	16.0 ±0.30	4.00 ±0.10	8.00 ±0.10	2.00 ±0.10	4.15 ±0.20	7.95 ±0.20	1.50 ±0.10	7.50 ±0.10	1.75 ±0.10	0.30 ±0.10	Max 0.10	0.90 ±0.20
1836	16.0 ±0.30	4.00 ±0.10	8.00 ±0.10	2.00 ±0.10	4.85 ±0.20	9.35 ±0.20	1.50 ±0.10	7.50 ±0.10	1.75 ±0.10	0.30 ±0.10	Max 0.10	0.90 ±0.20
3921	24.0 ±0.30	4.00 ±0.10	8.00 ±0.10	2.00 ±0.10	5.50 ±0.20	11.5 ±0.20	1.50 ±0.10	11.5 ±0.10	1.75 ±0.10	0.30 ±0.10	Max 0.10	0.90 ±0.20

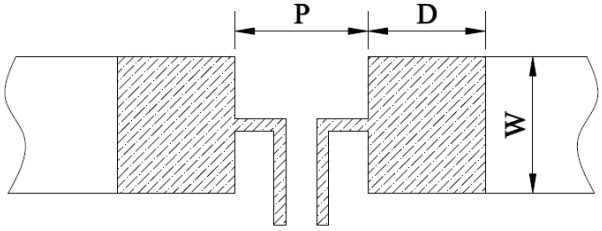
Reel Dimensions:



All dimensions in mm.

Size	0603	0805	1206	2010	2512	3921	4527	0508	0612	0815	1020	1225	0830	1530	1836	2043
A	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00	178 ±5.00
N	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00	60.0 ±2.00
W1	9.00 ±1.00	9.00 ±1.00	9.00 ±1.00	13.0 ±1.00	13.0 ±1.00	24.5 ±1.00	24.5 ±1.00	9.00 ±1.00	9.00 ±1.00	13.0 ±1.00	13.0 ±1.00	13.0 ±1.00	17.0 ±1.00	17.0 ±1.00	17.0 ±1.00	24.5 ±1.00

Recommended Land Pattern:

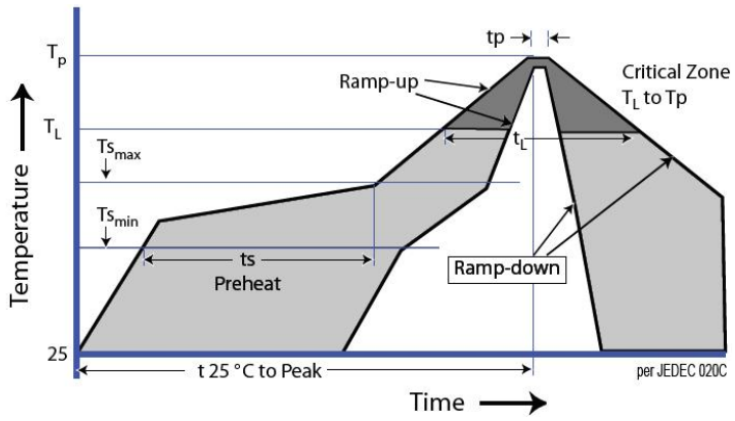


All dimensions in mm.

Type	Electrode Type	Resistance Range	P	W	D
WKL0603	A	5mΩ	0.50	0.92	1.35
		6mΩ 100mΩ	0.60		1.30
WKL0805	A	3mΩ	0.50	1.44	1.55
		4mΩ ~ 500mΩ	0.80		1.40
WKL1206	A	3mΩ	0.60	1.84	2.10
		4mΩ ~ 700mΩ	1.20		1.80
WKL2010	A	2mΩ	0.70	2.88	3.65
		3mΩ			
		4mΩ ~ 700mΩ	2.70		2.65
WKL2512	A	2mΩ	0.60	3.57	4.35
		3mΩ	0.90		4.20
		4mΩ ~ 700mΩ	3.10		3.10
WKL4320	A	2mΩ	1.10	5.75	6.43
		3mΩ	1.70		6.15
		4mΩ ~ 8mΩ	5.00		
		9mΩ ~ 100mΩ			4.50
WKL4527	A	2mΩ	1.20	8.05	6.65
		3mΩ ~ 100mΩ	5.20		4.65

Type	Electrode Type	Resistance Range	P	W	D
WKL0508	B	1mΩ ~ 100mΩ	0.60	2.30	1.10
WKL0612	B	1mΩ	0.50	3.68	1.35
		2mΩ ~ 100mΩ	0.60		1.30
WKL0815	B	1mΩ ~ 100mΩ	0.70	4.26	1.45
WKL1020	B	1mΩ ~ 100mΩ	1.00	5.75	2.25
WKL1225	B	1mΩ ~ 100mΩ	1.40	7.25	2.35
WKL0830	B	1mΩ ~ 100mΩ	0.95	8.63	2.28
WKL1530	B	1mΩ ~ 100mΩ	1.70	8.74	2.55
WKL1836	B	1mΩ ~ 100mΩ	2.10	10.35	2.70
WKL2043	B	1mΩ ~ 100mΩ	2.40	12.65	2.80

Soldering Profile:



Profile Feature	Pb-Free Assembly
Average Ramp-Up Rate (Ts_{max} to Tp)	3 °C/second max.
Preheat	
- Temperature Min (Ts_{min})	150 °C
- Temperature Max (Ts_{max})	200 °C
- Time (ts_{min} to ts_{max})	60-180 seconds
Time maintained above:	
- Temperature (T_L)	217 °C
- Time (t_L)	60-150 seconds
Peak Temperature (T_p)	260 +0 °C
Time within 5 °C of actual Peak Temperature (tp)	20-40 seconds
Ramp-Down Rate	6 °C/second max.
Time 25 °C to Peak Temperature	8 minutes max.

Storage Conditions:

Environment Conditions:

Products should be stored under the following environmental conditions.

- Temperature: +5 to +35°C
- Humidity: 45 to 85% relative humidity
- Do not keep products in environments where they may be subject to particulate contamination or harmful gases such as sulfuric acid or hydrogen chloride as it may cause oxidization on electrodes, resulting in poor solderability.
- Products should be stored in a space that does not expose it to high temperatures, vibration, or direct sunlight.
- Products should be stored in the original airtight packaging until use.