Innovative Service Around the Globe **YAGEO**

Low-Ohmic Chip Resistors

www.yageo.com

YAGEO
Phycomp

About Yageo

Founded in 1977, the Yageo Corporation has become a world-class provider of passive component services with capabilities on a global scale, including production and sales facilities in Asia, Europe and the Americas.

The corporation is uniquely positioned to provide one stop shopping, offering its complete product portfolio of resistors, capacitors and high frequency products in both commodity and specialty versions to meet the diverse requirements of customers.

Yageo currently ranks as the world No.1 in chip resistors, No. 3 in MLCCs and No. 3 in ferrite products, with 27 sales/service offices in 18 countries, 8 manufacturing sites, 5 JIT logistic outfits and 3 R&D centers worldwide. Ferroxcube and Vitrohm are part of Yageo group, who produce ferrites and leaded resistors.

In the fast-paced electronics field, with its trend toward miniaturization and shorter product cycles for consumer electronics and telecommunication applications, it became clear that future growth would demand globalization, and the ability to become part of customer supply chains through enhanced service. The corporation's global deployment strategy has thus always been based on providing customers with comprehensive passive component solutions.

Table of contents

Introduction

Yageo's low-ohmic chip resistor ranges are the ideal replacement for traditional wirewound and leaded products in modern power control circuits. Based on the company's thick film technology, these products exhibit far lower parasitic inductance than their wirewound and leaded counterparts.

The low-ohmic chip resistors also fully compatible with today's high volume pick-and-place assembly systems. As such, they offer attractive, cost-effective solutions to designers of low voltage power supplies and battery management systems.

The low temperature coefficient of resistance (TCR) of Yageo's low ohmic chip resistor minimizes the resistance change caused by self heating and high temperature environments.

Thermal EMF is an important consideration in low value resistors used in DC circuits. We utilize metal foil technology to produce resistors with low thermal EMF characteristics (below 0.03μV/°C).

Features

- Excellent T.C.R. performance
- Standardized sizes which makes them easily interchangeable
- Compatibility with surface-mount assembly processes
- Ultra-low resistance and narrow tolerance, suitable for current detection
- High component and equipment reliability
- RoHS/REACH compliant & Halogen free

Low-ohmic chip resistors in circuit

Low-ohmic resistors are used in power sensing applications, for example, to sense output current in power supplies and automotive engine management systems. As shown in Figure 1, a typical function for a low-ohmic chip resistor is as a current sensor (R_{sense}). This generates the sensing voltage V_s for a feedback control network through which an output current I_o passes. The sensing voltage triggers (MOSFET) switches, switching them ON and OFF to regulate the duty factor of the current passing through a choke L.

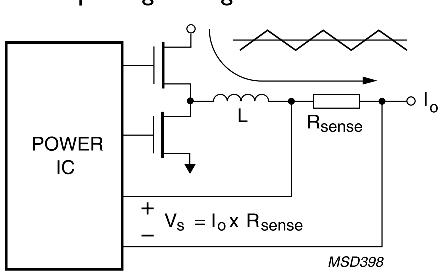


Figure 1 *Low-ohmic chip resistor in current sensing application*

The sensing voltage V_s is given by the simple relation:

$$V_s = I_o \times R_{sense}$$

This sensing voltage is generally set at around 100 mV both to save power and maintain satisfactory noise immunity. To sense a 5 A average output current, R_{sense} must be 100 mV/5 A = 20 mΩ. The power dissipation will then be:

$$P = I_o^2 R_{sense} = 5\text{ A} \times 5\text{ A} \times 20\text{ m}\Omega = 0.5\text{ W}$$

A low-ohmic chip resistor with a power rating 1.0 W would then be recommended for this application to provide an adequate safety margin.

Effect of component characteristics on current sensing applications

Average output current versus peak output current

In the feedback circuit of figure 1, the output current I_o through the choke L is not a pure DC but exhibits some ripple. The magnitude of the output ripple depends on the inductance of the choke - the higher the inductance, the lower the ripple. A high inductance choke, however, reduces the ability of the circuit to respond to high frequency transients. Such a choke will also be physically large, limiting the possibilities for miniaturization so essential to modern mobile equipment.

A trade-off is therefore necessary between choke volume and output current ripple. Experience indicates that a ripple of 0.04 provides a good compromise in this area. With this ripple value, the peak output current I_{peak} is 2% greater than the average current I_{avg}, i.e. $I_{peak} = 1.02 \times I_{avg}$ (Figure 2).

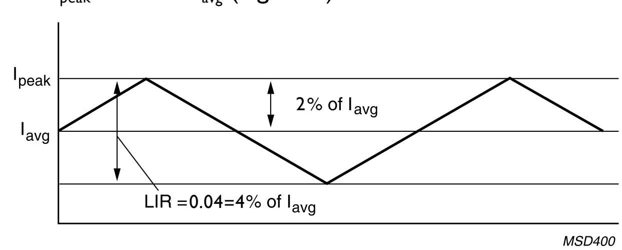


Figure 2 *Relationship between average output current and peak current with a ripple of 0.04*

Safety margin for setting the feedback voltage

The voltage generated across the sensing resistor is used in a feedback network to trigger the power switching IC. To allow for variation in the characteristics of the power switching IC, a safety margin for the sensing voltage is necessary. A -2% margin on sensing voltage is usually taken for general applications.

Tolerances on sensing resistance

As mentioned earlier, the relation between low-ohmic resistance, feedback sensing voltage and output current is given by $R_{sense} = V_s/I_o$. With an output ripple of 0.04, i.e. a 4% (± 2%) deviation on output current and a safety margin on the sensing voltage of -2%, the allowable deviation on R_{sense} is:

$$\frac{0.98 \times V_s}{0.98 \times I_o} \leq R_{sense} \leq \frac{V_s}{0.85 \times I_o}$$

With say, V_s= 100 mV and I_o= 5 A, the allowable low ohmic sensing resistance must lie in the range 19.2mΩ to 20.4mΩ.

Consideration of T.C.R. in current sensing applications

The above discussion does not, of course, take into account the effects of the temperature coefficient of resistance (T.C.R.) on current sensing applications. With a maximum deviation of 4% on output current and a safety margin of 2% on sensing voltage, the maximum allowable deviation on sensing resistance is 6%. The limit on T.C.R. is then given by:

$$R_{sense} (1+T.C.R. \times \Delta T) \leq 1.06\ R_{sense}$$

So

$$T.C.R. \leq \frac{0.06}{\Delta T} \text{ ppm/K}$$

Figure 3 plots the allowable T.C.R. values required to maintain tolerance on sensing resistance within the specified limit. T.C.R. values of Yageo's low-ohmic chip resistors fall well within these allowed limits over the temperature range 25°C to 155°C.

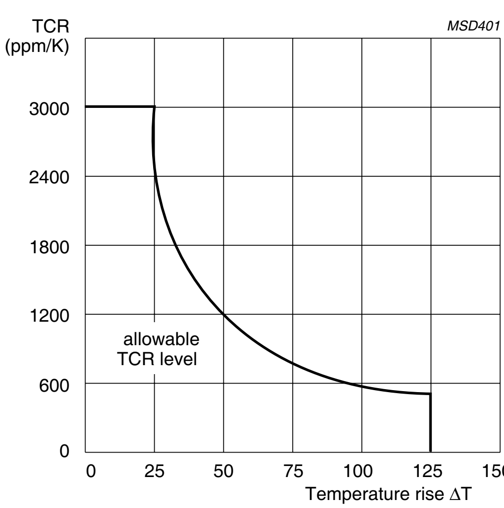


Figure 3 *Allowable T.C.R. values with 6% total deviation on output current and feedback voltage*

For some precision applications, the deviation in output current and the safety margin on sensing voltage may need to be reduced to say 1% on each, giving a total maximum deviation on sensing voltage of 2%. The limit on T.C.R. is then:

$$T.C.R. \leq \frac{0.02}{\Delta T} \text{ ppm/K}$$

which is plotted in Figure 4. Even with these tighter margins, the T.C.R. values of Yageo's low-ohmic resistor chips (shown in the shaded region in Figure 4) fall well within the allowable T.C.R. level. This shows that for most applications, T.C.R. is not an issue in sensing applications.

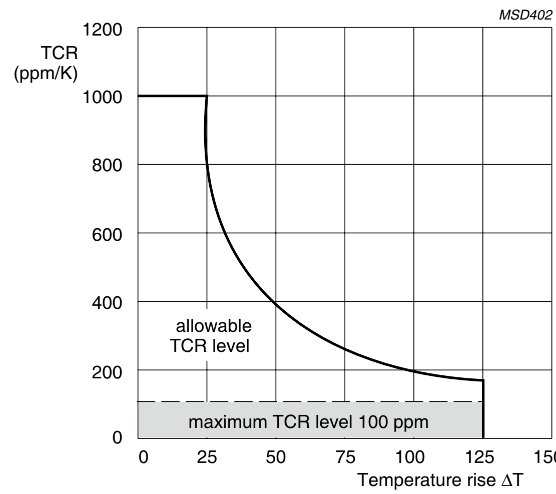


Figure 4 *Allowable T.C.R. values with 2% total deviation on output current and feedback voltage*

Detecting over current

As a means to detect the current passing through the transistor, see Figure 5, a resistor in series is added between an emitter and a ground. This resistor should neither emit smoke nor catch fire even when the switching transistor breaks down to be subjected to a larger current. In addition, reduced parasitic inductance is required, particularly for the high frequency switching control. Recommended resistors with low resistance are metal plate type, like PE series.

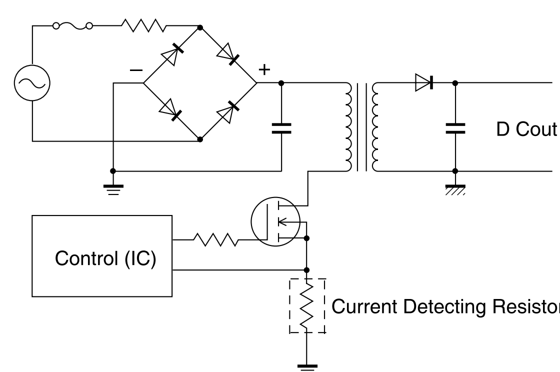


Figure 5 *Over current protection circuit*

DC/DC converter

The Figure 6 on the right shows the current detecting circuit of a DC/DC converter. The voltage across the current detecting resistor is fed back to control the output power. The resistance should be low to reduce power dissipation, and the resistor should stand against repeated rush current. Furthermore the self-inductance should be low for high frequency applications. Recommended types are Px series chip resistors. As for high frequency DC/DC converters, metal plate chip resistors PF series best fit in.

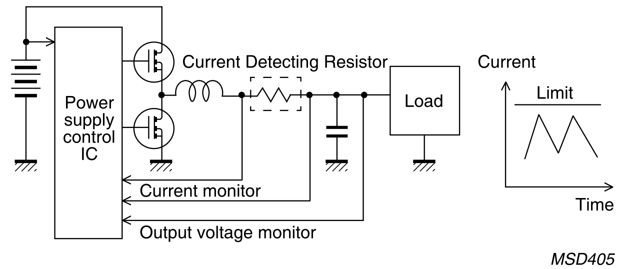


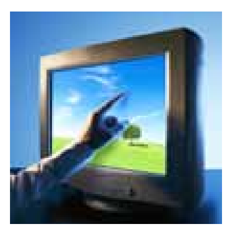
Figure 6 *DC/DC converter circuit*

Applications

Yageo's low-ohmic chip resistors are optimized for current sensing control. The low-ohmic current sensors, available from 0.05 to 5 watts, are applicable to battery pack, power supply and converter, and are suitable for use in diverse power control circuit of notebook computer or the hard disk of other compact portable devices that have current sensing and over current protection requirements. Featuring a comprehensive resistance range of 0.5 milli-ohms to 1 ohm and superior temperature coefficient (T.C.R.) performance is able to meet various customer demands and applications.

Consumer Goods

- **Home appliances**
- **LCD TV**
- **Digital camera**
- **Game console**



Computers

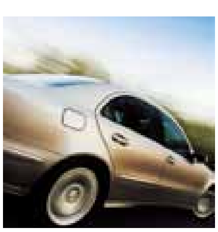
- **Notebook/tablet**
- **Server**
- **Disk drives**

Telecom

- **Mobile phones**
- **Base stations**
- **Modems**
- **Set-top-Box**

Power

- **Power supplies**
- **UPS**
- **Stepper motor**



Automotive

- **HVAC**
- **Body control module**
- **Tyre pressure monitoring**

Alternative Energy

- **Pulse loading**
- **Power inverter**
- **Signal conditioning**

Medical

- **Monitoring systems**
- **Diagnostic equipment**
- **Point-Of-Care**

Industrial

- **Industrial automation**
- **Lighting**
- **Drives and controls**

Low-Ohmic Chip Resistors Decision Tree (Metal Technology)

Current Sensor Low TCR, 0603 ~ 2512

Case Size	Resistance Range (mR)	Max. Rated Power (W)	
0603	5 ~ 100	0.5	PF/PE (1)
0805	3 ~ 100	0.5	PF/PE (1)
1206	1, 2, 3, 4	1	PR
	5 ~ 100	1	PF/PE (1)
2010	1, 2, 3, 4	1	PR
	5 ~ 100	1	PF/PE (1)
2512	1, 2, 4	3	PR
	3, 5	3	PA
	6 ~ 100	3	PF/PE (1)

(1) PE/PR/PA suit battery application

Current Sensor Low TCR , 3921 ~ 5931

Case Size	Resistance Range (mR)	Max. Rated Power (W)	
3921	0.2, 0.3, 0.5, 1, 2, 3, 4	3	PA (1)
	5 ~500	3	PE (1)
4520	0.2, 0.3, 0.5, 1, 2, 3, 4	5	PA (1)
	5 ~500	5	PE (2)
4527	0.2, 0.3, 0.5, 1, 2, 3, 4	5	PA (1)
	5 ~500	5	PE (2)
5931	0.2, 0.3, 0.5, 1, 2, 3, 4	10	PA (1)
	5 ~500	10	PE (1)

(1) Under development
(2) PE/PA suit battery application

Current Sensor Low TCR, Wide Terminal

Case Size	Resistance Range (mR)	Max. Rated Power (W)	
0306	5 ~ 100	1	PE [1]
0508	3 ~ 100	1.2	PE [1]
0612	1 ~ 9; 11 ~ 300	2	PE [1]
	10	2	PF
0830	1 ~ 100	2	PF/PE [1]
0815	1 ~ 100	1	PE [1]
1225	1 ~ 100	3	PF/PE [1]

(1) PE suits battery application

Current Sensor Low TCR, 4 Terminal

Case Size	Resistance Range (mR)	Max. Rated Power (W)	
0612	0.5, 0.75, 1	1	PS [1]
	2 ~ 100	1	PS [1]
1225	3 ~ 100	3	PS [1]

(1) PS suits battery application

Low-Ohmic Chip Resistors Decision Tree (Thick Film Technology)

Case Size	Min. Resistance (mR)	T.C.R[1] (ppm/°C)	Max. Rated Power (W)	
0201	100	200	1/20	PT[2]
0402	50	600	1/6	PT
	50	1000	1/16	RL
0603	50	400	1/3	PT
	10	1500	1/10	RL
0805	50	350	1/4	PT
	10	1500	1/4	RL
1206	100	100	1/2	PT
	10	1500	1/2	RL

(1) Lowest TCR (Depends on ohmic range)
(2) Under development

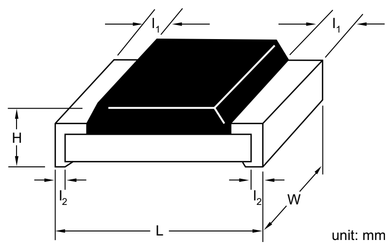
Case Size	Min. Resistance (mR)	T.C.R[1] (ppm/°C)	Max. Rated Power (W)	
1210	10	1500	1/2	RL
1218	10	2000	1	RL
1218	100	100	1	PT
	10	1500	3/4	RL
2512	100	100	2	PT
	10	1500	1	RL
0815 (wide terminal)	25	100	1	PT

(1) Lowest TCR (Depends on ohmic range)

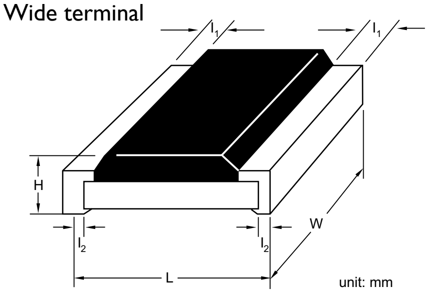
Jumper Chip Resistors Decision Tree (Thick Film Technology)

Case Size	Max. Resistance (mR)	Rated Current (A)	
0402	50	1	RC
	20	1.5	RL
	10	3	PT
0603	50	1	RC
	20	2	RL
	8	5	PT
0805	50	2	RC
	20	2.5	RL
	5	6	PT
1206	50	2	RC
	20	3.5	RL
	5	10	PT

Dimensions



Wide terminal



Type	Resistance range	L	W	H	l_1	l_2
RL0402 (1)	50mΩ ≤ R < 1Ω	1.00 ±0.10	0.50 ±0.05	0.35 ±0.05	0.20 ±0.10	0.25 ±0.10
RL0603 (1)	10mΩ ≤ R < 1Ω	1.60 ±0.10	0.80 ±0.10	0.45 ±0.10	0.25 ±0.15	0.25 ±0.15
RL0805 (1)		2.00 ±0.10	1.25 ±0.10	0.50 ±0.10	0.35 ±0.20	0.35 ±0.20
RL1206 (1)		3.10 ±0.10	1.60 ±0.10	0.55 ±0.10	0.45 ±0.20	0.45 ±0.20
RL1210 (1)		3.10 ±0.10	2.60 ±0.15	0.55 ±0.10	0.50 ±0.20	0.50 ±0.20
RL1218 (1)		3.05 ±0.15	4.60 ±0.20	0.55 ±0.10	0.45 ±0.25	0.50 ±0.25
RL2010 (1)		5.00 ±0.10	2.50 ±0.15	0.55 ±0.10	0.60 ±0.20	0.50 ±0.20
RL2512 (1)		6.35 ±0.10	3.20 ±0.15	0.55 ±0.10	0.60 ±0.20	0.50 ±0.20
PT0402 (1)	50mΩ ≤R < 1Ω	1.00 ±0.10	0.50 ±0.05	0.35 ±0.05	0.20 ±0.10	0.25 ±0.10
PT0603 (1)		1.60 ±0.10	0.80 ±0.10	0.45 ±0.10	0.25 ±0.15	0.25 ±0.15
PT0805 (1)		2.00 ±0.10	1.25 ±0.10	0.55 ±0.10	0.35 ±0.20	0.35 ±0.20
PT1206 (1)	20mΩ & 100mΩ ≤R < 1Ω	3.10 ±0.10	1.60 ±0.10	0.55 ±0.10	0.45 ±0.20	0.45 ±0.20
PT2010 (1)	100mΩ ≤R < 1Ω	5.00 ±0.10	2.50 ±0.15	0.55 ±0.10	0.60 ±0.20	0.50 ±0.20
PT2512 (1)		6.35 ±0.10	3.20 ±0.15	0.55 ±0.10	0.60 ±0.20	0.50 ±0.20
PE/PF0603 (2)	5mΩ ≤ R ≤ 100m	1.60 ±0.20	0.80 ±0.20	0.60 ±0.15	---	0.30 ±0.15
PF/PH 0805 (2)	3mΩ	2.10 ±0.20	1.35 ±0.20	0.65 ±0.20	---	0.75 ±0.15
	4mΩ	2.00 ±0.20	1.25 ±0.20	0.60 ±0.15	---	0.70 ±0.15
	5mΩ	2.00 ±0.20	1.25 ±0.20	0.60 ±0.15	---	0.63 ±0.15
PE/PF/PH 0805 (2)	6mΩ ≤ R ≤7mΩ	2.00 ±0.20	1.25 ±0.20	0.60 ±0.15	---	0.55 ±0.15
	8mΩ ≤ R ≤ 100mΩ	2.00 ±0.20	1.25 ±0.20	0.60 ±0.15	---	0.40 ±0.15
PF/PH0805 (1)	10mΩ ≤ R ≤ 50mΩ	2.03 ±0.25	1.27 ±0.25	0.33 ±0.12	0.38 ±0.25	0.38 ±0.25
PE/PF/PH 1206 (2)	3mΩ	3.20 ±0.20	1.60 ±0.20	0.60 ±0.15	---	1.30 ±0.20
	4mΩ	3.20 ±0.20	1.60 ±0.20	0.60 ±0.15	---	1.20 ±0.20

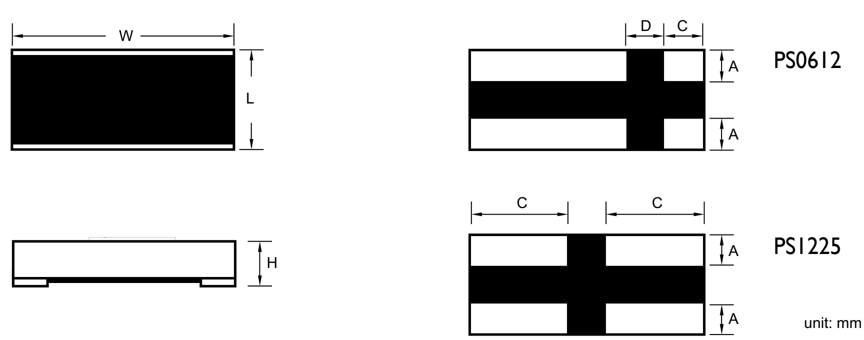
Note: 1. Apply to ordering codes ending in "L"
2. Apply to ordering codes ending in "Z"
Please contact sales offices, distributors and representatives in your region before ordering

Type	Resistance range	L	W	H	l_1	l_2
PE/PF/PH 1206 (2)	5mΩ ≤ R ≤8mΩ	3.20 ±0.20	1.60 ±0.20	0.60 ±0.15	---	1.15 ±0.20
	9mΩ ≤ R ≤ 100mΩ	3.20 ±0.20	1.60 ±0.20	0.60 ±0.15	---	0.58 ±0.20
PF/PH1206 (1)	10mΩ≤ R ≤ 50mΩ	3.20 ±0.25	1.60 ±0.25	0.60 ±0.25	0.50 ±0.25	0.65 ±0.25
PE/PF2010(2)	5mΩ ≤ R ≤9mΩ	5.00 ±0.20	2.50 ±0.20	0.60 ±0.15	---	1.50 ±0.20
	10mΩ ≤ R ≤ 100mΩ	5.00 ±0.20	2.50 ±0.20	0.60 ±0.15	---	0.60 ±0.20
PE/PF2512 (2)	1mΩ	6.30 ±0.20	3.10 ±0.20	0.60 ±0.15	---	2.93 ±0.20
	2mΩ	6.30 ±0.20	3.10 ±0.20	0.60 ±0.15	---	2.70 ±0.20
	3mΩ	6.30 ±0.20	3.10 ±0.20	0.60 ±0.15	---	2.50 ±0.20
	4mΩ	6.30 ±0.20	3.10 ±0.20	0.60 ±0.15	---	2.15 ±0.20
	5mΩ	6.30 ±0.20	3.10 ±0.20	0.60 ±0.15	---	1.95 ±0.20
	6mΩ ≤ R ≤8mΩ	6.30 ±0.20	3.10 ±0.20	0.60 ±0.15	---	1.90 ±0.20
	9mΩ ≤ R ≤ 100mΩ	6.30 ±0.20	3.10 ±0.20	0.60 ±0.15	---	0.95 ±0.20
PF2512 (1)	6mΩ	6.45 ±0.25	3.25 ±0.25	0.70 ±0.25	0.75 ±0.25	1.85 ±0.25
	7mΩ ≤ R ≤ 15mΩ	6.45 ±0.25	3.25 ±0.25	0.70 ±0.25	0.75 ±0.25	1.55 ±0.25
	20mΩ ≤ R ≤ 50mΩ (1W)	6.45 ±0.25	3.25 ±0.25	0.70 ±0.25	1.30 ±0.25	0.75 ±0.25
	20mΩ ≤ R ≤ 50mΩ (2W)	6.45 ±0.25	3.25 ±0.25	0.70 ±0.25	0.75 ±0.25	1.30 ±0.25
PE4520 (2)	5mΩ≤ R ≤ 7mΩ	11.10 ±0.30	5.10 ±0.30	0.65 ±0.20	---	3.60 ±0.30
	8mΩ≤ R ≤ 500mΩ	11.10 ±0.30	5.10 ±0.30	0.65 ±0.20	---	2.36 ±0.30
PE4527 (2)	5mΩ	11.50 ±0.20	7.00 ±0.20	0.60 ±0.15	---	2.90 ±0.20
	6mΩ ≤ R ≤ 500mΩ	11.50 ±0.20	7.00 ±0.20	0.60 ±0.15	---	2.60 ±0.20
PR1206 (2)	1mΩ ≤ R ≤ 6mΩ	3.20 ±0.25	1.60 ±0.25	0.64 ±0.25	0.50 ±0.25	0.50 ±0.25
PR2010 (2)	1mΩ ≤ R ≤ 3mΩ	5.10 ±0.25	2.54 ±0.25	0.80 ±0.25	1.30 ±0.25	1.30 ±0.25
	4mΩ ≤ R ≤ 100mΩ	5.10 ±0.25	2.54 ±0.25	0.64 ±0.25	0.80 ±0.25	0.80 ±0.25
PR2512 (1)	1mΩ ≤ R ≤ 2mΩ	6.40 ±0.20	3.20 ±0.20	0.75 ±0.15	1.20 ±0.20	1.20 ±0.20
	3mΩ ≤ R ≤ 5mΩ	6.40 ±0.20	3.20 ±0.20	0.55 ±0.10	0.60 ±0.20	0.60 ±0.20
PR2512 (2)	0.5mΩ ≤ R ≤ 4mΩ	6.25 ±0.25	3.30 ±0.25	0.78 ±0.25	1.88 ±0.25	1.88 ±0.25
	5mΩ ≤ R ≤ 75mΩ	6.25 ±0.25	3.30 ±0.25	0.64 ±0.25	1.11 ±0.25	1.11 ±0.25
PA2512 (1)	1mΩ ≤ R ≤ 10mΩ	6.50 ±0.20	3.20 ±0.20	0.65 ±0.15	0.90 ±0.20	0.90 ±0.20

Note: 1. Apply to ordering codes ending in “L”
2. Apply to ordering codes ending in “Z”
Please contact sales offices, distributors and representatives in your region before ordering

Wide terminal						
Type	**Resistance range**	**L**	**W**	**H**	**l_1**	**l_2**
PE0306 (2)	5mΩ ≤ R ≤ 100mΩ	0.90±0.20	1.70±0.20	0.65±0.20	---	0.25±0.15
PE0508 (2)	3mΩ ≤ R ≤ 100mΩ	1.35±0.20	2.10±0.20	0.65±0.20	---	0.43±0.15
PF/PE0612 (2)	1mΩ	1.60 ±0.20	3.20 ±0.20	0.60 ±0.15	---	0.55 ±0.20
	2mΩ ≤ R ≤ 4mΩ	1.60 ±0.20	3.20 ±0.20	0.60 ±0.15	---	0.40 ±0.20
	5mΩ ≤ R ≤ 300mΩ	1.60 ±0.20	3.20 ±0.20	0.60 ±0.15	---	0.30 ±0.20
PF0815 (1)	10/15/20mΩ	2.15 ±0.20	3.75 ±0.25	0.65 ±0.25	0.65 ±0.25	0.70 ±0.25
PF/PE0815 (2)	1mΩ	2.50 ±0.20	3.70 ±0.20	0.60 ±0.15	---	0.95 ±0.20
	2mΩ	2.50 ±0.20	3.70 ±0.20	0.60 ±0.15	---	0.75 ±0.20
	3mΩ ≤ R ≤ 100mΩ	2.50 ±0.20	3.70 ±0.20	0.60 ±0.15	---	0.60 ±0.20
PF/PE0830 (2)	1mΩ ≤ R ≤ 9mΩ	2.5±0.20	7.50±0.30	0.60±0.15	---	0.60 ±0.15
	10mΩ ≤ R ≤ 100mΩ	2.5±0.20	7.50±0.30	0.60±0.15	---	0.58 ±0.15
PF1225 (2)	1mΩ	3.10±0.20	6.30±0.20	0.60±0.15	---	1.15±0.20
	2mΩ ≤ R ≤ 100mΩ	3.10±0.20	6.30±0.20	0.60±0.15	---	0.50±0.20
PF/PE1225 (2)	1mΩ	3.10±0.20	6.30±0.20	0.60±0.15	---	1.15±0.20
	2mΩ ≤ R ≤ 100mΩ	3.10±0.20	6.30±0.20	0.60±0.15	---	0.50±0.20
PT0815	25mΩ ≤ R ≤ 50mΩ	2.00 ±0.10	3.70 ±0.10	0.50 ±0.10	0.35 ±0.20	0.40 ±0.20

4 terminal



Type	Resistance range	L	W	A	D	C	H
PS0612 (1)	3mΩ ≤ R ≤ 10mΩ	1.60±0.25	3.20±0.25	0.40±0.25	0.30±0.25	0.70±0.25	0.60±0.25
PS0612 (2)	0.5mΩ ≤ R ≤ 100mΩ	1.60±0.20	3.20±0.20	0.45±0.20	0.50±0.20	0.65±0.20	0.60±0.20
PS1225 (2)	3mΩ ≤ R ≤ 100mΩ	3.10±0.20	6.30±0.20	0.80±0.20	---	2.20±0.20	0.60±0.15

Note: 1. Apply to ordering codes ending in “L”
2. Apply to ordering codes ending in “Z”
Please contact sales offices, distributors and representatives in your region before ordering

General information

<table>
<tr><th colspan="13">T. C. R. - RL series</th></tr>
<tr><th>Type</th><th colspan="12">T.C.R</th></tr>
<tr><td></td><td colspan="3">50mΩ≤R<100mΩ</td><td colspan="3">100mΩ≤R<500mΩ</td><td colspan="6">500mΩ≤R<1Ω</td></tr>
<tr><td>RL0402</td><td colspan="3">±1000 ppm/°C</td><td colspan="3">±800 ppm/°C</td><td colspan="6">±300 ppm/°C</td></tr>
<tr><td></td><td colspan="3">10mΩ≤R≤36mΩ</td><td colspan="3">36mΩ<R≤91mΩ</td><td colspan="3">91mΩ<R≤500mΩ</td><td colspan="3">500mΩ<R<1Ω</td></tr>
<tr><td>RL0603</td><td colspan="3">±1 500 ppm/°C</td><td colspan="3">±1 200 ppm/°C</td><td colspan="3">±800 ppm/°C</td><td colspan="3">±300 ppm/°C</td></tr>
<tr><td></td><td colspan="2">10mΩ≤R≤18mΩ</td><td colspan="2">18mΩ<R≤47mΩ</td><td colspan="2">47mΩ<R≤91mΩ</td><td colspan="2">91mΩ<R≤360mΩ</td><td colspan="2">360mΩ<R≤500mΩ</td><td colspan="2">500mΩ<R<1Ω</td></tr>
<tr><td>RL0805 / RL1206 / RL2010</td><td colspan="2">±1 500 ppm/°C</td><td colspan="2">±1 200 ppm/°C</td><td colspan="2">±1 000 ppm/°C</td><td colspan="2">±600 ppm/°C</td><td colspan="2">±300 ppm/°C</td><td colspan="2">±200 ppm/°C</td></tr>
<tr><td>RL1210</td><td colspan="2">±1 500 ppm/°C</td><td colspan="2">±1 000 ppm/°C</td><td colspan="2">±800 ppm/°C</td><td colspan="2">±600 ppm/°C</td><td colspan="2">±300 ppm/°C</td><td colspan="2">±200 ppm/°C</td></tr>
<tr><td>RL2512</td><td colspan="2">±1 500 ppm/°C</td><td colspan="2">±1 200 ppm/°C</td><td colspan="2">±800 ppm/°C</td><td colspan="2">±600 ppm/°C</td><td colspan="2">±300 ppm/°C</td><td colspan="2">±200 ppm/°C</td></tr>
<tr><td></td><td colspan="3">10mΩ≤R≤30mΩ</td><td colspan="3">30mΩ<R≤56mΩ</td><td colspan="3">56mΩ<R≤180mΩ</td><td colspan="3">180mΩ<R<1Ω</td></tr>
<tr><td>RL1218</td><td colspan="3">±2 000 ppm/°C</td><td colspan="3">±1 000 ppm/°C</td><td colspan="3">±700 ppm/°C</td><td colspan="3">±250 ppm/°C</td></tr>
</table>

<table>
<tr><th colspan="10">Electrical characteristics</th></tr>
<tr><th>Global part number</th><th>Series</th><th>Size</th><th>Power rating</th><th>Max. voltage</th><th>Operating Temp. range</th><th>Resistance range</th><th>Tol.</th><th colspan="2">T. C. R.</th></tr>
<tr><td>RL0402xR-07xxxxL</td><td rowspan="10">RL</td><td>0402</td><td>1/16W</td><td>(PxR)^1/2</td><td rowspan="10">-55°C to 125°C</td><td>50mΩ ≤ R < 1Ω</td><td rowspan="10">±1%
±2%
±5%</td><td colspan="2" rowspan="10">Pls refer to above table
“T. C. R. - RL series“</td></tr>
<tr><td>RL0603xR-07xxxxL</td><td>0603</td><td>1/10W</td><td>(PxR)^1/2</td><td rowspan="9">10mΩ ≤ R < 1Ω</td></tr>
<tr><td>RL0805xR-07xxxxL</td><td rowspan="2">0805</td><td>1/8W</td><td>(PxR)^1/2</td></tr>
<tr><td>RL0805xR-7WxxxxL</td><td>1/4W</td><td>(PxR)^1/2</td></tr>
<tr><td>RL1206xR-07xxxxL</td><td rowspan="2">1206</td><td>1/4W</td><td>(PxR)^1/2</td></tr>
<tr><td>RL1206xR-7WxxxxL</td><td>1/2W</td><td>(PxR)^1/2</td></tr>
<tr><td>RL1210xR-07xxxxL</td><td>1210</td><td>1/2W</td><td>(PxR)^1/2</td></tr>
<tr><td>RL1218xK-07xxxxL</td><td>1218</td><td>1W</td><td>(PxR)^1/2</td></tr>
<tr><td>RL2010xK-07xxxxL</td><td>2010</td><td>3/4W</td><td>(PxR)^1/2</td></tr>
<tr><td>RL2512xK-07xxxxL</td><td>2512</td><td>1W</td><td>(PxR)^1/2</td></tr>
<tr><td>PT0402xRx07xxxxL</td><td rowspan="5"></td><td rowspan="3">0402</td><td>1/16W</td><td rowspan="5"></td><td rowspan="5">-55°C to 155°C</td><td rowspan="5">50mΩ ≤ R < 1Ω</td><td rowspan="5"></td><td rowspan="3">50mΩ ≤ R < 68mΩ
68mΩ ≤ R < 100Ω
100mΩ ≤ R < 1Ω</td><td rowspan="3">±600 ppm/°C
±300 ppm/°C
±200 ppm/°C</td></tr>
<tr><td>PT0402xRx7WxxxxL</td><td>1/8W</td></tr>
<tr><td>PT0402xRx7TxxxxL</td><td>1/6W</td></tr>
<tr><td>PT0603xRx07xxxxL</td><td rowspan="2">0603</td><td>1/10W</td><td rowspan="2">50mΩ
50mΩ < R < 68mΩ
68mΩ ≤ R < 100Ω
100mΩ ≤ R < 1Ω</td><td rowspan="2">0/+400 ppm/°C
0/+350 ppm/°C
0/+300 ppm/°C
±200 ppm/°C</td></tr>
<tr><td>PT0603xRx7WxxxxL</td><td>1/5W</td></tr>
</table>

Global part number	Series	Size	Power rating	Max. voltage	Operating Temp. range	Resistance range	Tol.	T. C. R.	
PT0805xR-07xxxxL	PT	0805	1/8W	(PxR)^1/2	55°C to 155°C	50mΩ ≤ R < 1Ω	±1% ±2% ±5%	50mΩ 50mΩ < R < 68mΩ 68mΩ ≤ R < 100Ω 100mΩ ≤ R < 1Ω	0/+350 ppm/°C 0/+300 ppm/°C 0/+250 ppm/°C ±100 ppm/°C
PT0805xR-7WxxxxL			1/4W						
PT1206xR-07xxxxL		1206	1/4W			20mΩ & 100mΩ ≤ R < 1Ω		20mΩ 50mΩ ≤ R < 100mΩ 100mΩ 100mΩ ≤ R < 1Ω	0/+600 ppm/°C 0/+300 ppm/°C ±100 ppm/°C ±75 ppm/°C
PT1206xR-7WxxxxL			1/2W						
PT2010xK-07xxxxL		2010	3/4W			100mΩ ≤ R < 1Ω		100mΩ 100mΩ < R < 1Ω	±100 ppm/°C ±75 ppm/°C
PT2010xK-7WxxxxL			1W						
PT2512xK-07xxxxL		2512	1W			100mΩ ≤ R < 1Ω		100mΩ 100mΩ < R < 1Ω	±100 ppm/°C ±75 ppm/°C
PT2512xK-7WxxxxL			2W						
PE0603xRM57xxxxxx	PE	0603	1/2W	(PxR)^1/2	-55°C to 155°C	5mΩ ≤ R ≤ 100mΩ	±1% ±2% ±5%	±75 ppm/°C	
PE0805xRM47xxxxxx		0805	1/2W			3mΩ ≤ R ≤ 100mΩ			
PE1206xRM47xxxxxx		1206	1W			5mΩ ≤ R ≤ 100mΩ			
PE2010xKM7Wxxxxx		2010	1W			5mΩ ≤ R ≤ 100mΩ			
PE2512xKM7Txxxxxx		2512	3W			1mΩ ≤ R ≤ 100mΩ			
PE4520xKM07xxxxx		4520	5W			5mΩ ≤ R ≤ 500mΩ			
PE4527xKM7Txxxxx		4527	5W			5mΩ ≤ R ≤ 500mΩ			
PF0603xRM57xxxxxx	PF	0603	1/2W	(PxR)^1/2	-55°C to 155°C	5mΩ ≤ R ≤ 100mΩ	±1% ±2% ±5%	±75 ppm/°C	
PF0805xRM07xxxxxx		0805	1/8W			3mΩ ≤ R ≤ 100mΩ			
PF0805xRM7Wxxxxxx			1/4W						
PF0805xRM7Txxxxxx			1/3W						
PF0805xRM47xxxxxx			1/2W						
PF1206xxM07xxxxxx		1206	1/4W						
PF1206xxM7Wxxxxxx			1/2W						
PF1206xxM47xxxxxx			1W						
PF2010xKM7Wxxxxxx		2010	1W			5mΩ ≤ R ≤ 100mΩ			
PF2512xKM07xxxxxx		2512	1W			1mΩ ≤ R ≤ 100mΩ			
PF2512xKM7Wxxxxxx			2W						
PF2512xKM7Txxxxxx			3W						
PH0805xRM07xxxxxx	PH	0805	4/5W	(PxR)^1/2	-55°C to 155°C	4mΩ ≤ R ≤ 50mΩ	±1% ±2% ±5%	±75 ppm/°C	
PH1206xRM07xxxxxx		1206	1W						

Global part number	Series	Size	Power rating	Max. voltage	Operating Temp. range	Resistance range	Tol.	T. C. R.	
PR1206xKE07xxxxxx	PR	1206	1/4W	(PxR)^1/2	-55°C to 155°C	1mΩ ≤ R ≤ 6mΩ	±1% ±2% ±5%	±50 ppm/°C	
PR1206xKE7Wxxxxxx			1/2W						
PR1206xKE47xxxxxx			1W						
PR2010xKE07xxxxxx		2010	1/2W			1mΩ ≤ R ≤ 100mΩ			
PR2010xKE7Wxxxxxx			1W						
PR2512xKx07xxxxxx		2512	1W			0.5mΩ ≤ R ≤ 5mΩ		0.5mΩ ≤ R ≤ 2mΩ 3mΩ ≤ R ≤ 5mΩ	±200 ppm/°C ±100 ppm/°C
PR2512xKx7Wxxxxxx			2W						
PR2512xKE7Txxxxxx			3W			0.5mΩ ≤ R ≤ 10mΩ		±50 ppm/°C	
PR2512DKE07xxxxxx			1W			7mΩ ≤ R ≤ 75mΩ	±0.5%		
PR2512DKE7Wxxxxxx			2W						
PA2512xKF07xxxxL	PA	2512	1W	(PxR)^1/2	–55°C to 155°C	1mΩ≤ R ≤ 10mΩ	±1% ±5%	±100 ppm/°C	
PA2512xKF7WxxxxL			2W						
PA2512xKF7TxxxxL			3W						

Wide terminal

Global part number	Series	Size	Power rating	Max. voltage	Operating Temp. range	Resistance range	Tol.	T. C. R.
PT0815xK-07xxxxL	PT	0815	1/2W	(PxR)^1/2	-55°C to 155°C	25mΩ ≤ R ≤ 50mΩ	±1% ±2% ±5%	±100 ppm/°C
PT0815xK-7WxxxxL			1W					
PE0306xRM07xxxxx	PE	0306	1W	(PxR)^1/2	–55°C to 155°C	5mΩ≤ R ≤ 100mΩ	±1% ±2% ±5%	±75 ppm/°C
PE0508xRM07xxxxx		0508	1.2W			3mΩ≤ R ≤ 100mΩ		
PE0612xKM7Wxxxxx		0612	2W			1mΩ≤ R ≤ 300mΩ		
PE0815xKM7Wxxxxx		0815	1W			1mΩ≤ R ≤ 100mΩ		
PE0830xKM07xxxxx		0830	2W			1mΩ≤ R ≤ 100mΩ		
PE1225xKM7Wxxxxx		1225	3W			1mΩ≤ R ≤ 100mΩ		
PF0612xKM7Wxxxxxx	PF	0612	2W	(PxR)^1/2	-55°C to 155°C	1mΩ ≤ R ≤ 300mΩ	±1% ±2% ±5%	±75 ppm/°C
PF0815xKM7Wxxxxx		0815	1W			1mΩ ≤ R ≤ 100mΩ		
PF0830xKM07xxxxx		0830	2W			1mΩ ≤ R < 100mΩ		
PF1225xKM7Wxxxxx		1225	3W			1mΩ ≤ R < 100mΩ		

4 terminal

Global part number	Series	Size	Power rating	Max. voltage	Operating Temp. range	Resistance range	Tol.	T. C. R.
PS0612xKM07xxxxx	PS	0612	1W	(PxR)^1/2	–55°C to 155°C	0.5mΩ≤ R ≤ 100mΩ	±1% ±5%	±75 ppm/°C
PS1225xKM07xxxxx		1225	3W			3mΩ≤ R ≤ 100mΩ		

Jumper

Global part number	Series	Size	Operating Temp. range	Max. Resistance	Rated Current
RL0402-R-070RL	RL	0402	-55°C to 155°C	20mΩ	1.5A
RL0603-R-070RL		0603		20mΩ	2A
RL0805-R-070RL		0805		20mΩ	2.5A
RL1206-R-070RL		1206		20mΩ	3.5A
PT0402-R-070RL	PT	0402	-55°C to 155°C	10mΩ	3A
PT0603-R-070RL		0603		8mΩ	5A
PT0805-R-070RL		0805		5mΩ	6A
PT1206-R-070RL		1206		5mΩ	10A

Environmental characteristics

Performance test		Test method	Procedure	Requirements
Life		MIL-STD-202G-method 108A	1 000 hours at 70°C ±5°C applied RCWV 1.5 hours on, 0.5 hours off, still air required	±(1%+ 0.0005Ω) <20mΩ for jumper
High temperature exposure		MIL-STD-202G-method 108A	1 000 hours at maximum operating temperature depending on specification, unpowered	±(1%+ 0.0005Ω) <20mΩ for jumper
Moisture resistance		MIL-STD-202G-method 106F	Each temperature / humidity cycle is defined as 8 hours (method 106F), 3 cycles / 24 hours for 10d with 25°C / 65°C 95% R.H	±(0.5%+ 0.0005Ω) <20mΩ for jumper
Solderability	Wetting	IPC/JEDECJ-STD-002B testB	Electrical test not required. Magnification 50X Lead-free solder bath at 245 ±3°C Dipping time: 3 ±0.5 seconds	Well tinned (≥95% covered) No visible damage
	Resistance to soldering heat	MIL-STD-202G-method 210F	Lead-free solder, 260°C, 10 seconds immersion time	±(0.5%+ 0.0005Ω) <10mΩ for jumper No visible damage
Short time overload		MIL-R-55342D-para 4.7.5	PT/RL standard power: 6.25 times of rated power for 5 seonds at room temperature PA/PR/PE/PF/PH/PS & PT/RL high power: 5 times of rated power for 5 seconds at room temperature PT/RL jumper: 2.5 times of rated current for 5 seconds at room temperature	±(1%+ 0.0005Ω) <10mΩ for jumper No visible damage

Packing quantities

Size code	Tape width	178mm / Ø7" reel		254mm / Ø10" reel	330mm / Ø13" reel
		Paper	Embossed	Paper	Paper
0306	8mm	5 000	---	---	---
0402	8mm	10 000	---	20 000 (1)	50 000 (1)
0508	8mm	5 000	---	---	---
0603	8mm	5 000	---	10 000 (1)	20 000 (1)
0612	8mm	---	5 000	---	---
0805	8mm	4 000 (2) / 5 000	---	10 000 (1)	20 000 (1)
0815	8mm	---	4 000	---	---
0830	16mm	---	4 000	---	---
1206	8mm	4 000 (2) / 5 000 (1)	4 000	10 000 (1)	20 000 (1)
1210	8mm	5 000	---	10 000 (1)	20 000 (1)
1218	12mm	---	4 000	---	---
1225	12mm	---	4 000	---	---
2010	12mm	---	4 000 / 2 000 (3)	---	---
2512	12mm	---	4 000 / 2 000 (3)	---	---
4520	24mm	---	2 000	---	---
4527	24mm	---	2 000	---	---

Note: (1) RL/PT series only
(2) PF/PH series with ordering code ending in "L"
(3) PR series with ordering code ending in "Z"

Cross reference

Yageo	Vishay	Rohm	KOA	Cyntec	TT/IRC	Susumu	Features
RL/PT Series	D..LR/ CRCW,RCWE	UCR	SR73/ UR73	RLT	LRC, LRF, LVC	RLT	Thick Film 0201~2512, 0R1~0R91, Current sensing
PR/PF Series	WSL/WSLP	PMR/PML	TLR	RLT	ULR, LVC	KRL, RL	Metal Alloy, 0603~4527, 0R001~0R1, low TCR, used in middle/high power
PT0402	RCWE0402	UCR01	SR731E	RLT0510	LVC0402	RLT0510	0402, 0R1~0R91 Thick Film current sensing
PF0603	WSL0603	PMR03	-	RL0816	-	-	0603, 0R005~0R1, TC75, Metal Foil, current sensing
PF0805	WSL0805	PMR10	-	RL1220	-	-	0805, 0R004~0R1 , TC75, Metal Foil, current sensing
PF4527	WSR2/3/5	-	SL2/ SLN2	-	-	-	Metal Alloy, 4527, 5W, low TCR, high power current sensing

Explanation of ordering code

P T 2 5 1 2 F K - 0 7 0 R 1 L

Series name (code 1-2)
RL = Thick film low ohmic
PT = Thick film low ohmic low T. C. R.
PA/PR/PF/PH/PE =
Current sensor - low T. C. R.
PS = 4 terminal, Current sensor

Size code (inch / metric) (code 3-6)
0306 = 0.8 x 1.6
0402 = 1.0 x 0.5
0508 = 1.25 x 2.0
0603 = 1.6 x 0.8
0612 = 1.6 x 3.2
0805 = 2.0 x 1.25
0815 = 2.15 x 3.75
0830 = 2.0 x 7.5
1206 = 3.2 x 1.6
1210 = 3.2 x 2.5
1218 = 3.2 x 4.5
1225 = 3.2 x 6.3
2010 = 5.0 x 2.5
2512 = 6.35 x 3.2
4520 = 11.0 x 5.0
4527 = 11.0 x 7.0

Tolerance (code 7)
F = ±1%
G = ±2%
J = ±5%
"–" for Jumper ordering

Packing style (code 8)
R = Paper tape reel
K = Embossed plastic tape reel

T.C.R (code 9)
E = ±50 ppm/°C
M = ±75 ppm/°C
F = ±100 ppm/°C
"–" Based on spec. (– for RL/PT only)

Taping Reel (code 10-11)
07 = 7 inch Dia. reel
10 = 10 inch Dia. reel
13 = 13 inch Dia. reel
7W = 7 inch Dia. reel 2 x standard power type
7T = 7 inch Dia. reel 3 x standard power type
47 = 7 inch Dia. reel 4 x standard power type
57 = 7 inch Dia. reel 5 x standard power type

Resistance (code 12-16)
There are 2~5 digits indicated the resistance value. Letter R is decimal point.
Ex:
0R = Jumper
0R1 = 0.1Ω
0R01 = 0.01Ω
0R001= 0.001Ω
0U5= 0.0005Ω

Default Code (code 17)
L / Z = Default code

Customer Support & Distribution Network

We bring to the market a proven innovative tradition and a commitment to service second to none.

Yageo sales representatives are available to visit you to discuss the technical and commercial issues appropriate to your project or requirement. Customer service can initiate new orders, change orders, request air shipments or drop shipments, product samples, and generally support your business on a day to day basis.

Our sales/services offices are strategically located to serve our customers worldwide and our international distributor network improve our product availability, delivery lead time and our service anywhere in the world.

Please see back cover for contact details of your local Yageo organization.

We support our customers with extensive literature including datasheets, brochures and application notes, which are also available electronically on our website at: **www.yageo.com**

In addition, our field application engineers constantly strive wherever possible, to work closely with customers to aid them with design-in and provide them with the support they need to remain competitive in their markets.

Disclaimer

All product specifications, statements, information and data (collectively, the "Information") are subject to change without notice.

All Information given herein is believed to be accurate and reliable, but is presented without guarantee, warranty, or responsibility of any kind, expressed or implied.

Statements of suitability for certain applications are based on our knowledge of typical operating conditions for such applications, but are not intended to constitute -and we specifically disclaim-any warranty concerning suitability for a specific customer application or use. This Information is intended for use only by customers who have the requisite experience and capability to determine the correct products for their application. Any technical advice inferred from this Information or otherwise provided by us with reference to the use of our products is given gratis, and we assume no obligation or liability for the advice given or results obtained.

Although we design and manufacture our products to the most stringent quality and safety standards, given the current state of the art, isolated component failures may still occur. Accordingly, customer applications which require a high degree of reliability or safety should employ suitable designs or other safeguards (such as installation of protective circuitry or redundancies) in order to ensure that the failure of an electrical component does not result in a risk of personal injury or property damage.

Although all product-related warnings, cautions and notes must be observed, the customer should not assume that all safety measures are indicated or that other measures may not be required.

YAGEO - A GLOBAL COMPANY

ASIA

Dongguan, China
Tel. +86 769 8772 0275
Fax. +86 769 8791 0053

Hong Kong, China
Tel. +852 2342 6833
Fax. +852 2342 6588

Mudu, China
Tel. +86 512 6651 8889
Fax. +86 512 6651 9889

Qingdao, China
Tel. +86 532 8797 0533
Fax. +86 532 8797 0533

Suzhou, China
Tel. +86 512 6825 5568
Fax. +86 512 6825 5386

Tokyo, Japan
Tel. +81 3 6809 3972
Fax. +81 3 6809 3982

Seongnam, Korea
Tel. +82 31 712 4797
Fax. +82 31 712 5866

Kuala Lumpur, Malaysia
Tel. +60 3 8063 8864
Fax. +60 3 8063 7376

Singapore
Tel. +65 6244 7800
Fax. +65 6244 4943

Taipei, Taiwan
Tel. +886 2 6629 9999
Fax. +886 2 6628 8886

EUROPE

Roermond, Benelux
Tel. +31 475 385 555
Fax. +31 475 385 589

Hamburg, Germany
Tel. +49 4121 870 189
Fax. +49 4121 870 271

Munich, Germany
Tel. +49 8990 7784 380
Fax. +49 8990 7784 3819

Szombathely, Hungary
Tel. +36 94 517 702
Fax. +36 94 517 701

Milan, Italy
Tel. +39 02 6129 1017
Fax. +39 02 6601 7490

Moscow, Russian Federation
Tel. +7 916 625 92 38
Fax. +7 498 610 07 07

NORTH AMERICA

San Jose, U.S.A.
Tel. +1 408 240 6200
Fax. +1 408 240 6201

For a complete listing of all Yageo sales offices, distributors, and representatives, please visit "contact us" at

www.yageo.com

Printed in Taiwan   Document order number: YL 100 00137   Date of release: July 2012

Innovative Service Around the Globe YAGEO