

Applications of Power Resistors
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1. Fixed Resistors

The fixed resistor is an electronic part to freely control the electric energy. It has following functions: suppressing electric current, converting energy into heat as a pseudoload, suppressing the surge voltage that causes an adverse impact on the semiconductor circuit by converting it into heat, measuring the current, monitoring and measuring the passing electric power, stabilizing the circuit by converting current into voltage, matching line impedance, preventing the reflection at the line termination, converting current into voltage at the termination of the transmission control system and splitting voltage. As described above, its intended usage is various and application range is wide. The resistor by Nikkohm is roughly categorized into three types: precision resistor, power resistor and RF resistor. The precision resistor is an electronic part designed especially to retain strict resistivity for a long time rather than to endure a large amount of energy. The RF resistor is designed to retain pure resistivity in high-frequency area rather than pursuing the precision of resistance value. The power resistor has a high calorific power ranging from 5W to 1KW and is designed in structure to efficiently discharge heat to outside. Now we describe the application of the power resistor.

The characteristics of fixed resistor are specified in the item of specifications of the resistor. Figure 1 shows the major specification items of the fixed resistor.

Specifications	Power resistor	Precision resistor	RF resistor
Resistance value	0.0005-100 Ohms	10-1M Ohms	50 Ohms
Resistance temperature coefficient	50-250ppm/K	1-10ppm/K	50ppm/K
Resistance value tolerance	1-10%	0.001-0.1%	1%
Rated power	5-10,000W	<0.5W	0.5-250W

Table1. Precision, power and RF resistors.

2. Power Resistor

The industrial power resistor by Nikkohm is used in many fields of power electronics. Power electronics is widely applied to electric power semiconductors; thyristor, GTO thyristor, IGBT, and power MOS, etc. due to significant technical innovation and excellent efficiency of its computerized facility. Moreover, it is also applied to the industrial machinery related to the various social infrastructure such as power generation, electrical transformation, power factor improvement, frequency conversion between 50 and 60 Hz, voltage increase/decrease, and motor control, etc. The power resistor always exists in every power electronics field.

Power plant	Building facility	Transportation facility	Industrial machinery	Others
Plant facility	UPS	Train control device	Machining center	Audio instrument for professional use
Frequency conversion between 50 and 60 Hz	Private power generator	Automotive control device	Numerical controlled machine tool	High definition CRT monitor
Power rate improvement device	Elevator	Aircraft control device	Welding machine	General-purpose UPS
AC transmission facility	Air conditioning facility	Vessel control device	Coating machine	Antifreeze heater

Electric transformation facility	Blower facility		Assembly robot	Constant-temperature heater
Wind generator plant facility	Access facility to electricity		Induction heating and drying apparatus	Dew condensation prevention heater
Solar cell generator facility	Water supply and sewerage systems		Induction heating and carburizing apparatus	
			Semiconductor manufacturing device	
			Industrial high-frequency power supply	
			Automatic warehouse	
			Conveyer device	
			Facility power supply	

Table 2. Market of power resistors.

3. Inverter/ Converter

The power electronics that is often applied to facility or devices in Figure 1 is an electronic circuit called inverter. The inverter is a circuit used to control a motor with a high performance efficiently by converting the DC of commercial power with fixed frequency to AC after converting it AC to DC to obtain the AC power supply with arbitrary frequency and phase. It can be applied to the devices consuming small electric power such as digital camera, DVD player, and HDD drive as an example. It is also widely used in the facility consuming large electric power such as the high-speed skyscraper elevator and power plant. Now we describe the application of power resistor to the general motor inverter of 0.5 to 100 KW class.

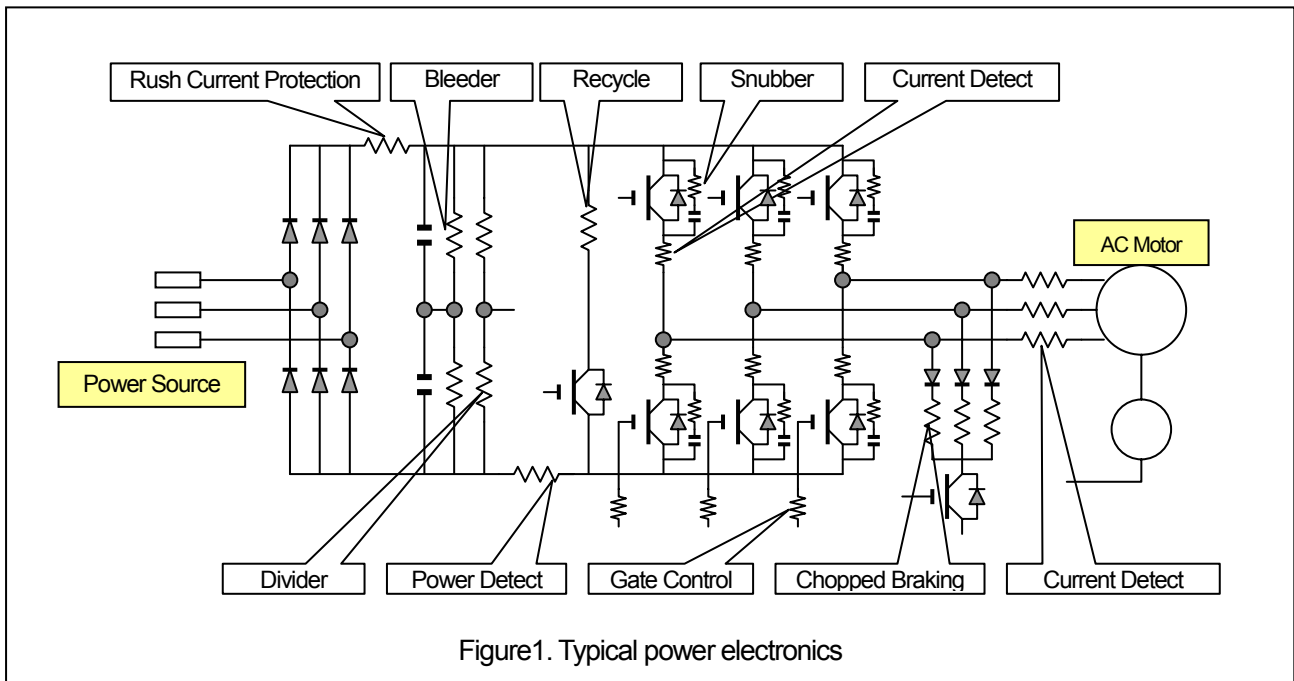


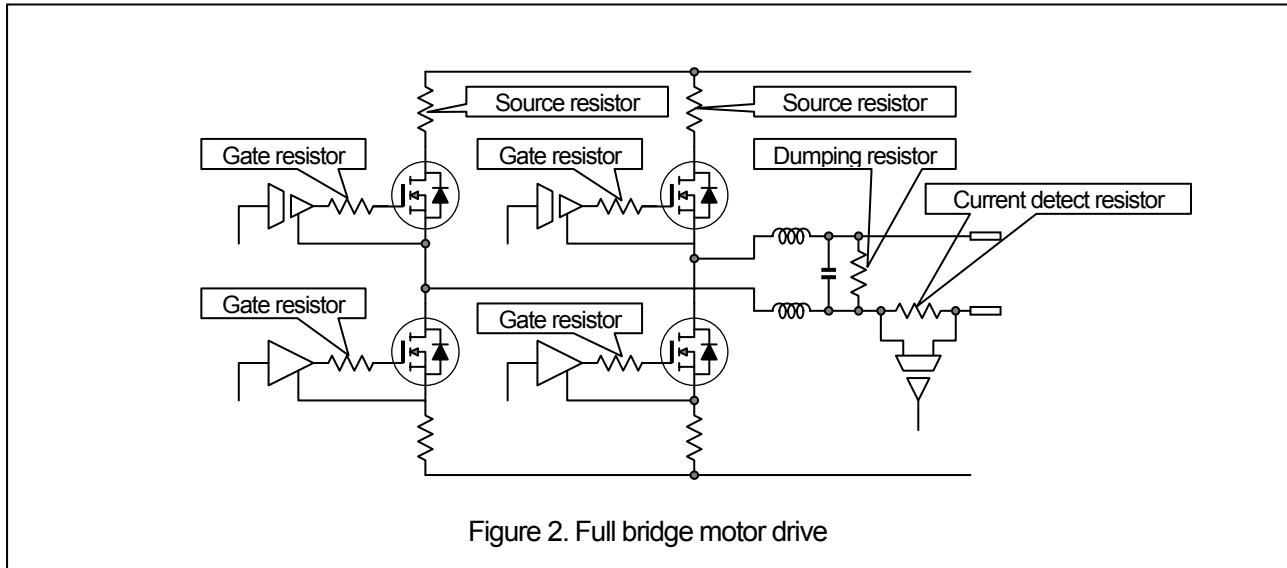
Figure1. Typical power electronics

Resistor	Operation	Notes	P/N Selection
Rush Current Protection	Restricts the current to charge the rectifier capacitor when turning power on.	Intermittent and a large amount of current continuing for a second flows. Therefore, be careful so that the rush current does not exceed the rated power.	Wire Wound Multiple RNP100S
Bleeder	Stabilizes the electric potential of the midpoint when connecting an electrolytic condenser in series to increase the withstand voltage of the condenser as well as discharging after operation.	The stable DC current flows. Use after reducing rated power load of the resistor.	RNP20S, RNP50S
Recycle	This is a regenerative braking resistance. It saves electricity by returning the electromotance of motor rotating inertially and also restricts its voltage increase.	Intermittent and a large amount of current continuing for a second flows. Therefore, be careful so that the rush current does not exceed the rated power.	Wire Wound Multiple RNP100S
Snubber	Drives the inductive load and reduces	The large amount of 10kHz or	RNP20S

	the impulse energy generated when switching the semiconductor switch by converting it into heat.	100kHz rush current with the pulse width of several microseconds flows continuously and repeatedly. Select the resistor taking both impulse withstand voltage and average power into consideration.	RNP50S
Current Detect, Power Device	Monitors and controls the drain/collector current of the semiconductor.	Measures the current of semiconductor elements such as P-MOS and IGBT to prevent the breakdown by current.	WSL, RCS, NSS
Current Detect, Motor	Monitors current of each phase of motor.	Monitors current of each phase of the polyphase motor to detect the motor abnormality.	WSL, RCS, NSS
Chopped Braking	Controls the current for intermittent electrical braking to raise the speed of response to decelerating of the servomotor.	Intermittent and a large amount of current continuing for a second flows. Therefore, be careful so that the rush current does not exceed the rated power.	Wire Wound Multiple RNP100S RPG RFJ
Gate Control	Controls the gate current of power MOS and IGBT, etc. to be the most appropriate level.	It is a resistor matched with the gate capacitance and manages the pulse signal for gate On/Off. Therefore, use a resistor with pure resistivity in high-frequency area.	RNP20S, RNP50S
Power Detect	The DC voltage after AC-DC conversion is stable and already known. So it calculates the motor output power from the passing electric power and controls it.	To measure all currents to supply to load, use the low resistance value of 0.1-0.5 milliohms. Also use the shunt resistor of 1A or 500A class.	WSL, RCS, NSS
Voltage Divider	It is a resistor for divided voltage to measure the DC voltage after AC-DC conversion.	It is a simple resistance of divided voltage. Use the resistor of several tens ohms after reducing the load of rated power to avoid excess current flow.	RNP20S RNP50S

4. Full bridge motor control

Half bridge switching circuit and full bridge switching circuit are used for the DC-DC switching power supply and DC motor control. These switching power supplies use power devices such as power transistor, power MOS, and IGBT. Figure 2 shows the representative examples of the full bridge motor control, which use various power resistors that are different in performance.



Resistor	Operation	Notes	P/N Selection
Source Current Protection	Prevents the devices from damage by overcurrent flow within a short period before activation of the protective circuit in case that the excess ON current flows due to load trouble, etc.	Resistance value must be 1 ohm or less, therefore calculate the rated power of resistor from the average electric power and the ON current.	RNP20S RNP50S
Gate Control	Controls the gate current of power MOS and IGBT, etc. to be the most appropriate level.	It is a resistor matched with the gate capacitance and manages the pulse signal for gate On/Off. Therefore, use a resistor with pure resistivity in high-frequency area.	RNP20S, RNP50S
Load Current Detect	In case of short-circuit of load or load motor locking, it prevents the device from damage by overcurrent flow into the switching power supply	To measure all currents to supply to load, use the low resistance value of 0.1-0.5 milliohms. Also use the shunt resistor of 1A or 500A class.	WSL, RCS, NSS
Damping Resistor	Prevents peak of the output LC filter characteristics from generating when the load impedance varies by connecting capacitive or inductive load.	The voltage applied to the resistor is DC; therefore, select a resistor that is excellent in high-frequency characteristics with attention to the rated power and load reduction rate of the resistor.	RNP20S RNP50U RNP50S RNP100S

5. Network for loudspeaker

The loudspeaker system for professional audio instruments can match the electric signal impedance with the air one. The matching is performed by acoustic synthesis in the air after splitting the frequency into multiple ranges such as low-frequency range, mid-frequency range and high-frequency range and performing the electroacoustic transformation since the impedance matching over the entire audio-frequency ranges is difficult for technical reasons. When inputting the low-frequency signal of several hundreds Hz into a tweeter designed for reproduction of high frequency by force, some malfunction such as speaker failure may occur. Therefore, do not input the signal of which frequency is far from that specified for the speaker.

Accordingly, in case of multiway loudspeaker system, insert filters called dividing network between each speaker and the power amplifier to divide the electric signal of several hundreds Watt into respective frequency ranges. The dividing network is a LC filter to input/output high electric power. The transfer rate (amount of attenuation) of the passing range of the LC filter is not flat and ripples due to the affect of the stray capacitance and stray inductance. To prevent it and achieve almost ideal dividing network configuration, use the dumping resistance. It is desirable to use the power resistor of which frequency dependence of the resistance value is extremely reduced.

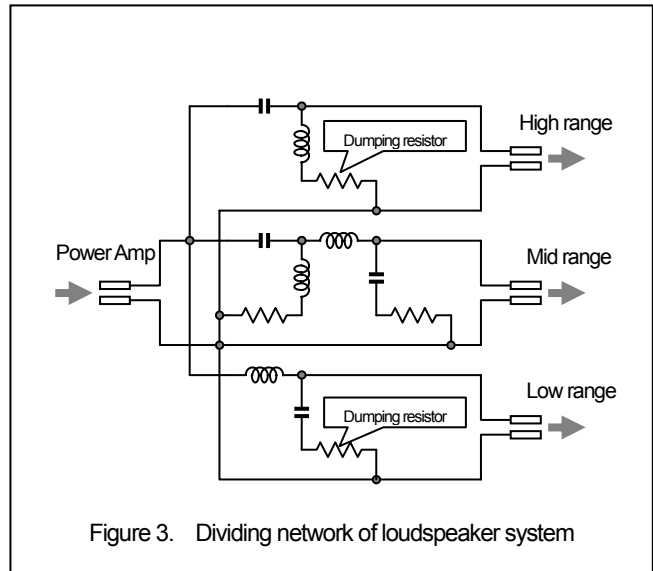
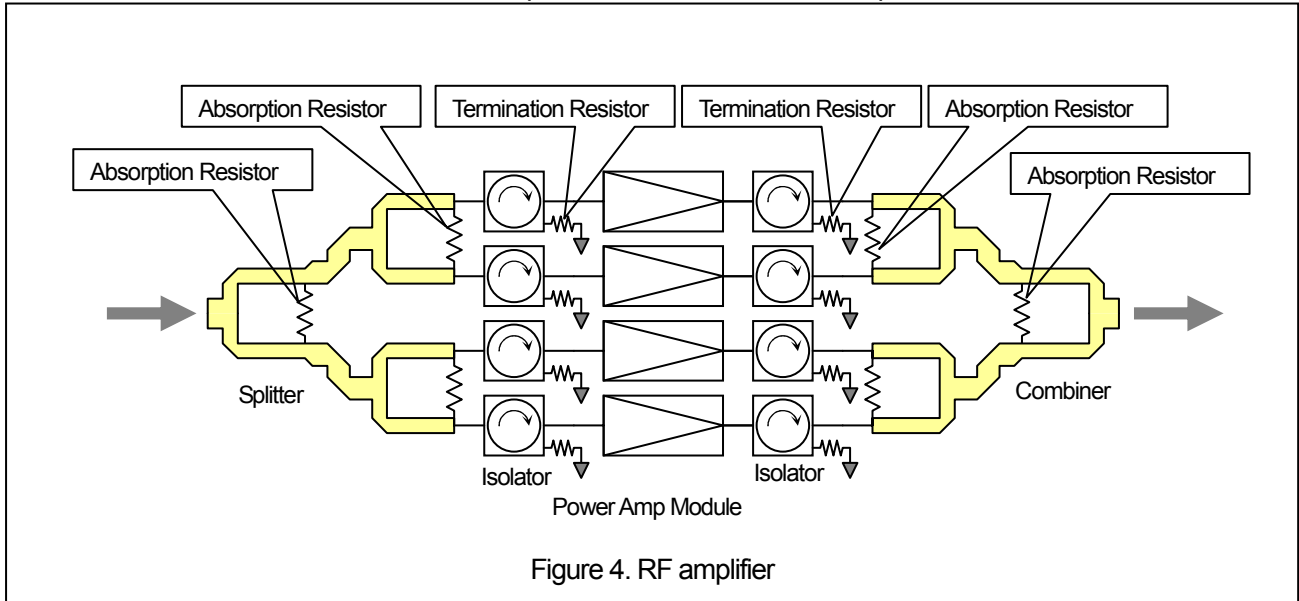


Figure 3. Dividing network of loudspeaker system

Resistor	Operation	Notes	P/N Selection
Damping Resistor	Prevents the resonance of dividing network.	Intermittent and a large amount of current continuing for 0.1 second flows. Therefore, be careful so that the rush current does not exceed the rated power.	RNP100S RPG300, RPJ200

6. High-frequency linear amplifier

The electric amplifier of the high-frequency power supply and fixed stations for mobile communication often connects power modules of 30W class in series to obtain 100W output. The Wilkinson branching filter may be used when operating and connecting power modules in series, and supplying the high-frequency input signal to multiple power modules. The Wilkinson multiplexer may be used when synthesizing multiple outputs of power module into one output. The absorption resistor is used for the Wilkinson circuit. To connect an amplifier to the next device, an isolator is often inserted between the output and next device since the output impedance of the amplifier is difficult to match with the input impedance of the next device. The isolator is used by terminating one terminal of the three-terminal circulator with the resistor equivalent to the characteristic impedance.



Resistor	Operation	Notes	P/N Selection
Absorption Resistor	Matches the transmission line impedance of the Wilkinson circuit.	Select the high power resistor that is compact and excellent in the high-frequency characteristics. Use 100-200-300-400-600 ohms for resistance value.	RNP20S RFRF RFRS RFH, RFJ
Termination	Terminates one terminal of the circulator with the resistor with same resistance value as the characteristic impedance to use it as an isolator.	Select the high power resistor that is compact and excellent in high-frequency characteristics. Since the consumption power becomes extremely huge, use the resistor that withstands high electric power. The resistance value is 50 ohms.	RFTF RFTS RNP10S RNP20S

End

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