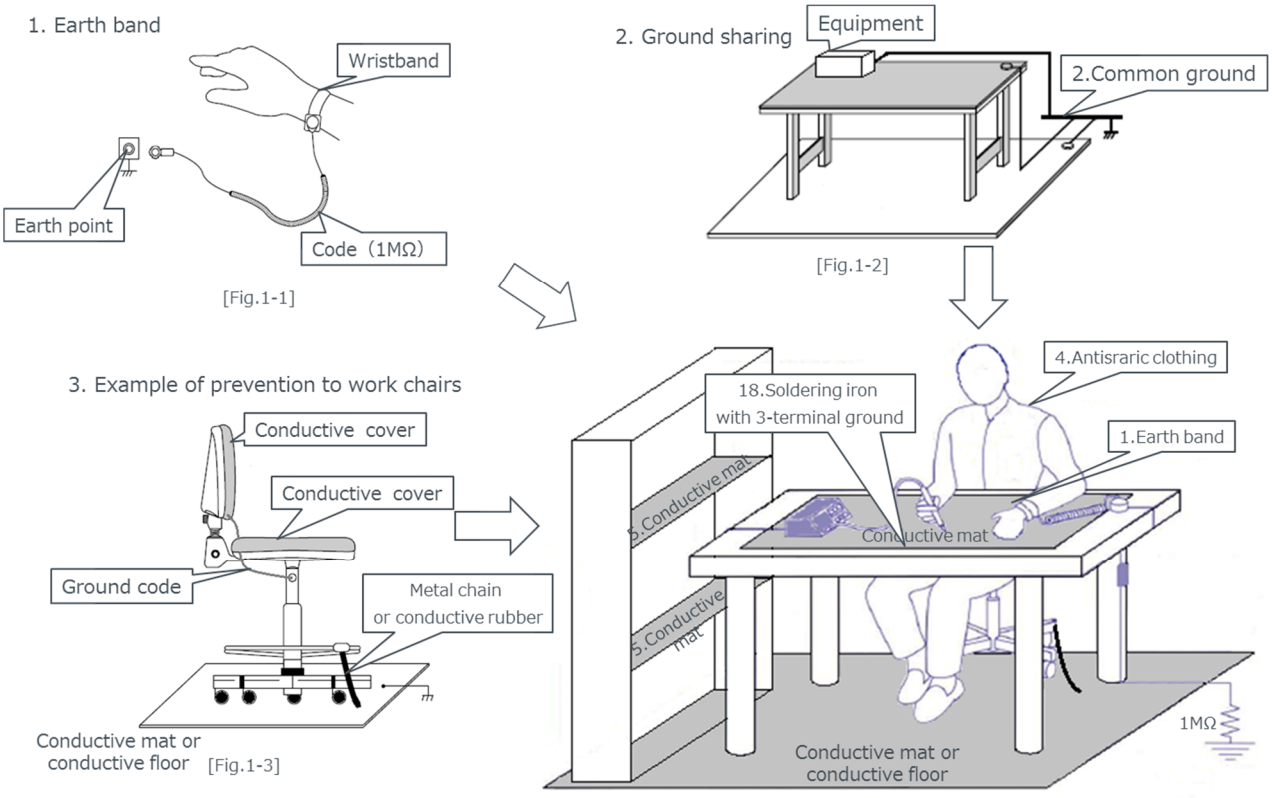
Surge prevention for laser diodes

This application note describes surge prevention for laser diodes.

Examples of surge prevention

Category	No.	contents	example
Work environment	1	Secure the grounding properly by oneself.	Attach the grounding band through 1Ωresistor.
	2	Standardize the grounding for workbench, inspection equipment and mounting platform.	Standardize the grounding for shield room when using there.
	3	Secure the grounding for the work chair which is electrically charged.	Cover the work chair with the electrostatic cover and attach the ground chain.
	4	Wear the conductive clothing.	
	5	Install the conductive mat in the product rack.	
	6	Use the conductive material to made the trays used in the process.	resistance value（10^6~10^9Ω/□）
	7	Use ion blowing or work in a weak ion atmosphere in conductive environment.	
	8	Control the humidity of the room atmosphere	Target 50±10% RH.
equipment	9	Wire to each measurement power supply through noise filters.	
	10	Install a static eliminator on the belt that touches the equipment to prevent it from being charged.	
	11	Secure the grounding of the product suction pads.	
	12	Prevent chatter from occurring in a relay that connects to the power supply.	
	13	Use a power supply with no ripple.	
Operation	14	Do not turn the power supply ON/OFF while the specified voltage is applied, when measuring electrical characteristics.	Turn off the power supply by dropping the volume resistors, turn it on and then raise it to the specified voltage.
	15	Do not turn ON/OFF the power to the lines or lights in the same room when assembling Laser Diode and adjusting operations.	
	16	Adjust initially the voltage of the volume resistance which controls the power supply voltage to the lowest point. （Volume resistance is often set at an intermediate value.）	
other	17	Use the conductive gloves and finger sacks.	
	18	Connect the end of the soldering iron to the ground.	Use a soldering iron with three-terminal.
	19	Check the effectiveness of static elimination if iron blowing is used.	
	20	Use the volume resistors with no entanglement.	Replace the volume resistors on a regular basis.

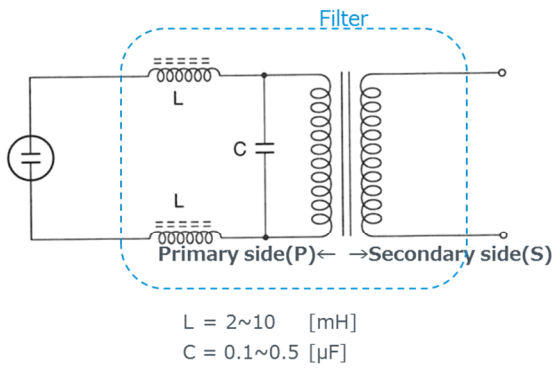


[Fig.1-1] [Fig.1-2] [Fig.1-3] [Fig.1-4]

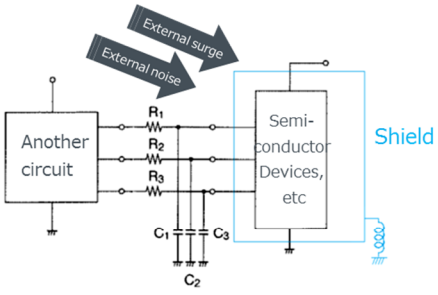
Measures against noise and surge voltage

Generally, the electronic devices are designed including about 10% increase or decrease as changes of the consumer power. However, if a machine that generates surge voltage is used in the vicinity, malfunctions or malfunctions caused by fluctuations in the power supply voltage may occur. This is due to a surge superimposed on the power lines and a surge of impulse state can be induced in case of lightning, etc. In response to that, it could be reduced by inserting the filter like [Fig.2-1] into the AC line side. Even if a surge and static electricity do not indirectly enter from the AC line, if there is a risk of direct application to components including semiconductor devices in the circuit board, the shield is required to be attached and the ground impedance to the shield is also required to be low value. [Fig. 2-2]

In case that static electricity or surge pulse may be applied directly as noise, as a special case, a protective circuit may be inserted as shown in the figure. The time constant of Rx × Cx should be set to the range suitable for absorbing surge pulse without affecting the operation.



[Fig. 2-1]



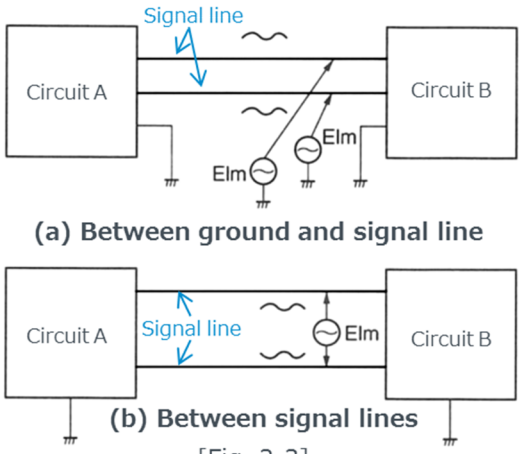
[Fig. 2-2]

Variety of noises

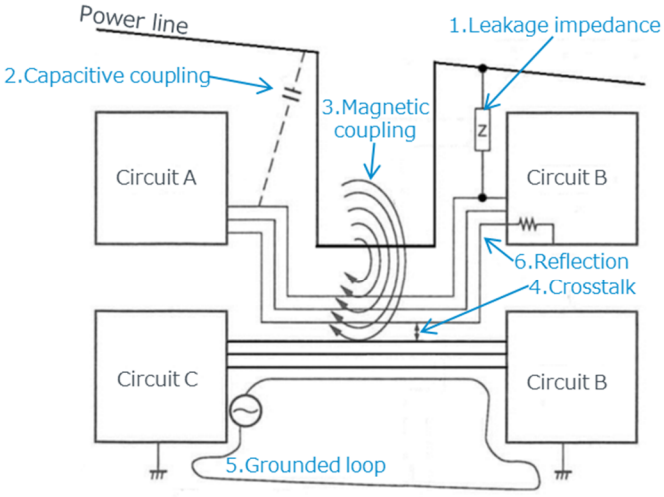
Some of the noise that can cause implementation problems is (a) generated between the ground and signal lines and (b) induced between the signal lines. [Figure 2-3]

These have different effects on the devices and how to deal with them. The following is examples of coupling a noise source and a signal line. (The conceptual diagram of a power line as a noise source is shown in [Fig. 2-4].)

1、By conduction	The leakage impedance between noise source and signal line.
2、By electrostatic induction	The capacitive coupling between noise source and signal line.
3、By magnetic induction	The mutual conductance between noise source and signal line.
4、By crosstalk	When two or more signal lines are adjacent to each other, electrostatic or electromagnetic induction induces a noise voltage on one of the signal lines.
5、By grounded loop	The potential difference between two points becomes a noise when the signal Lines are installed for transmission and reception.
6、By reflection	Reflected waves due to impedance mismatch in signal lines are superimposed on the signal.



[Fig. 2-3]



[Fig. 2-4]

Noise Reduction

To create a noise-free system, find the source of the noise and eliminate or reduce it. Try not to pick up noise. Use a circuit with a large noise margin. Provide protection circuits.

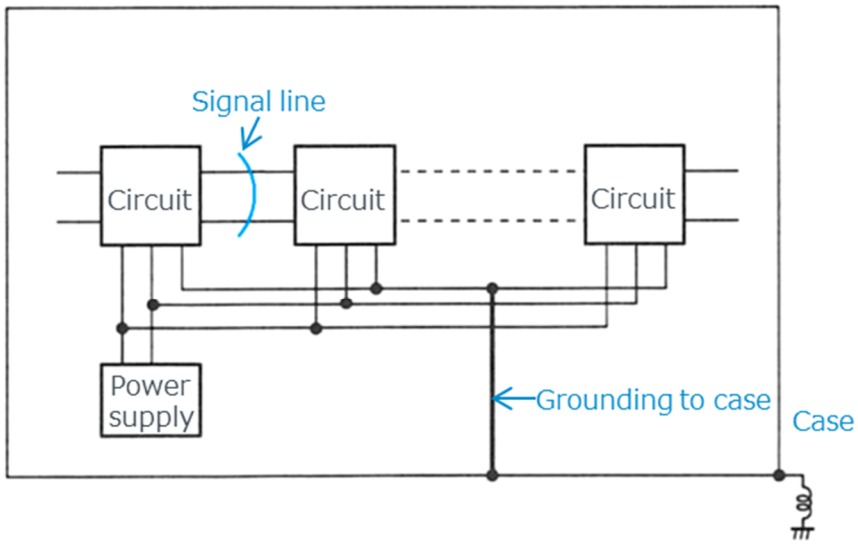
1. Countermeasures at the noise source

The most effective countermeasure is to treat the source of the noise. This can be done by using diodes, or resistors, capacitors, and capacitors in parallel with the relay coil. The surge voltage can be reduced by inserting a filter. Also, for noise passing through the AC power supply line, a filter can be inserted into the source power line. For devices that generate a strong electric field, if a countermeasure is implemented on the source side, such as applying a shield to the device that generates a strong electric field, the disturbed device will be subjected to a disturbance.

No system-wide measures are required. Other measures, such as separating it from the source of the problem, are also possible.

2. Grounding line measures

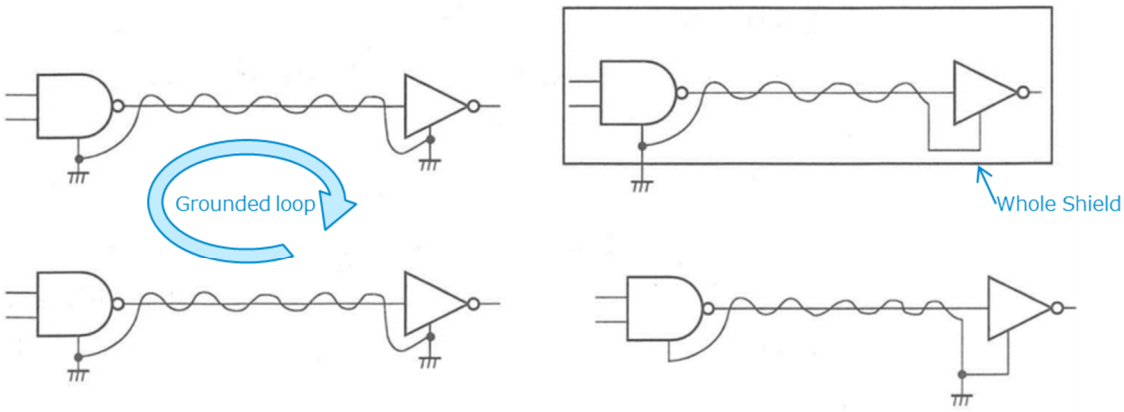
The circuit system grounding line should be dedicated and completely separated from the other power lines and other grounding systems to eliminate the current flowing through the grounding system to the circuit system. In addition, only one point of grounding between the circuit system and the enclosure is required, and the circuit system and the enclosure must be do not form a closed loop. [Figure 2-5]



[Fig. 2-5]

3. Shield measures

Shielding the signal lines, and the entire system, is a good way to reduce the impact of external noise. In case of noise due to electrostatic coupling, cover it with a good conductor and ground it. This allows noise that would be included on the signal line in the absence of shielding to be induced in the shielded line and it is bypassed to ground. Other examples of shielding are the commonly used twisted-pair wires. Noise is reduced if the two signal lines are symmetrical in terms of signal source, receiver circuit and ground noise source. If the twisted-bitch of the signal line is also made smaller than the transmission distance, it can be balanced and external noise is reduced. In the case of twisted pair wires, a grounding loop may occur, but it can be eliminated as shown in [Fig. 2-6].



(a) Bad example with the grounded loop

(b) Good example with no grounded loop

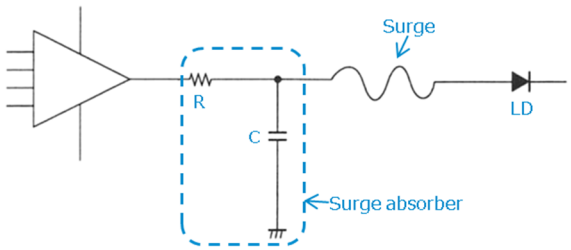
[Fig. 2-6]

4. Filter measures

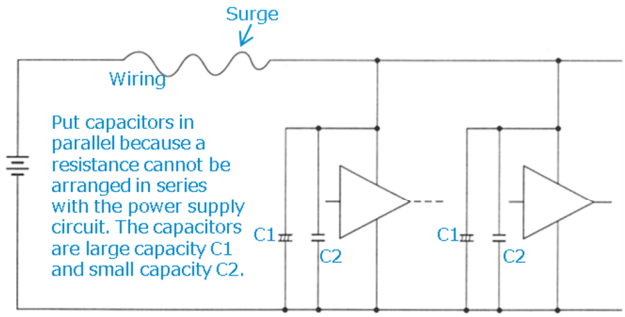
Generally, power supply noise tends to enter through the AC lines, so AC line filters are installed on the source side or the AC power supply side of the circuit system. It is also necessary to reduce the power supply impedance from the circuit system side as much as possible, so capacitors are inserted at each point of the power supply line to reduce the impedance to noise. In this case, it is desirable to insert in parallel a large capacitor as a bypass for relatively low frequencies and a small capacitor with low impedance for high frequencies.

5. Surge Protection

Circuit systems can be subjected to surge voltage effects. The main examples are listed here. When an LD is used in the same set as an oscilloscope, if the high voltage circuits are close to each other, surge voltages may be applied due to discharge. [Fig.2-7] and [Fig.2-8] show examples of LDs with resistors and capacitors between their terminals to absorb and reduce surge voltage. How to reduce the surge voltage is a major factor for improving reliability. [Fig. 2-7] is an example where a capacitor and a resistor are inserted to protect the output end of the LD to reduce the surge induced in the lead wire. [Fig. 2-8] shows an example of absorbing a surge entering the power supply, and to prevent the surge destruction of LDs, it is necessary to search for the surge penetration path and the penetration terminal and take the measures described above. The next thing that is often overlooked is that there is a case where a potential difference is caused by a surge on the line of the power supply line that is originally thought to be equipotential, and the LD may be destroyed. In this case, it is necessary to take measures to prevent surge-induced damage to the line by using an arrangement and wiring system that does not cause a surge, by applying a shield, and by considering the ground point.



[Fig. 2-7]

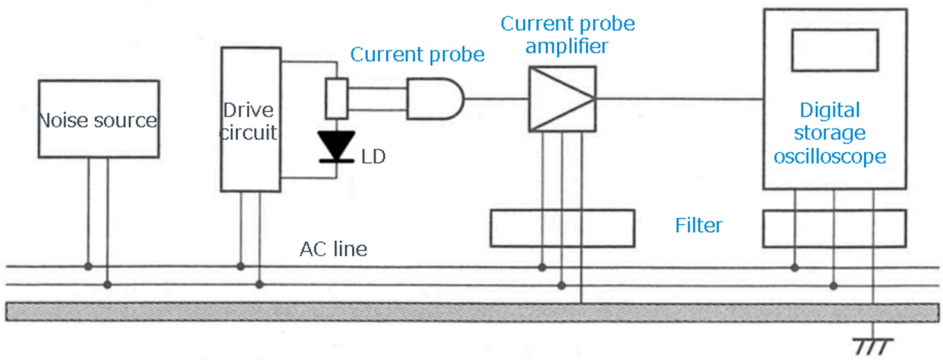


[Fig. 2-8]

6. Surge measurement method

In the previous section, we have discussed how to remove noise that causes surges.

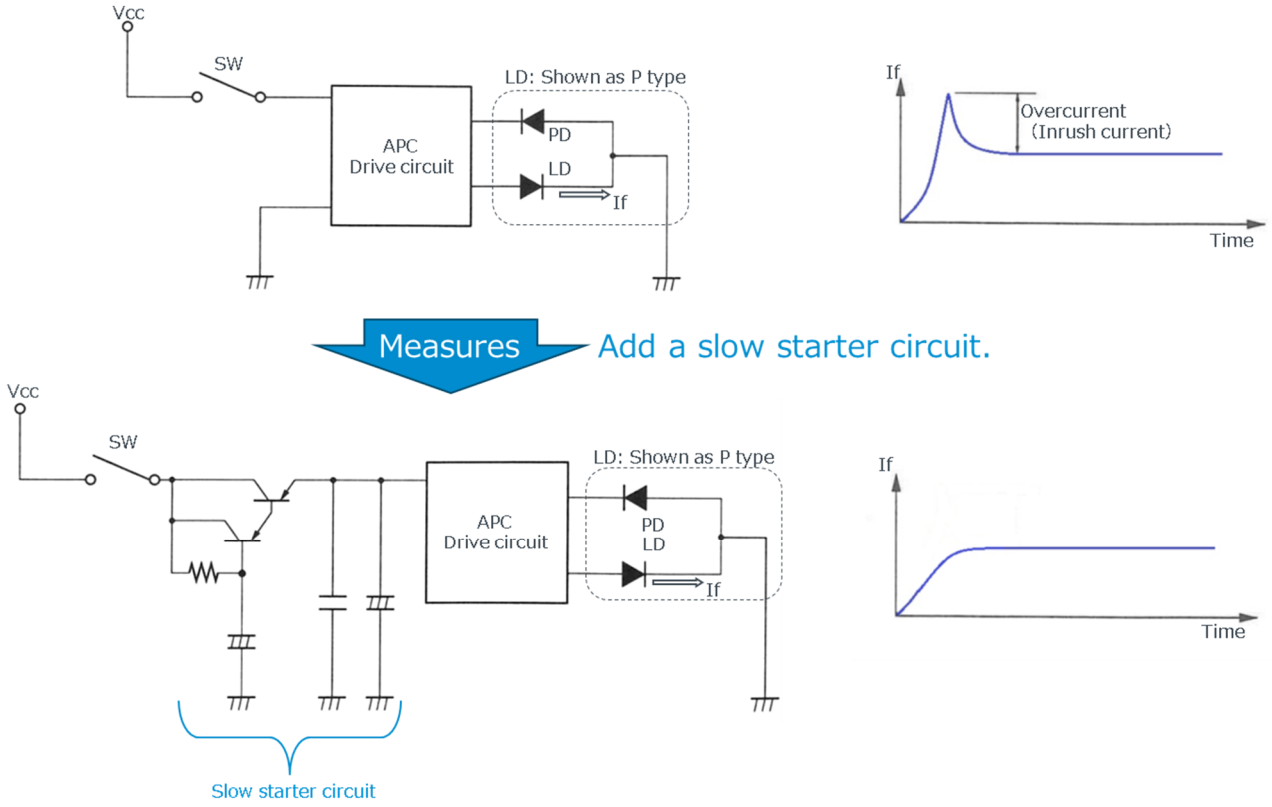
Please design and develop your circuits and systems with these measures in mind. After the circuit and system are decided, it is necessary to check the current in the LD drive circuit for actual surges, as close as possible to the actual drive conditions. For this purpose, as shown in [Fig. 2-9], use a rolling mode with a current probe and a digital storage oscilloscope to confirm that no surge is generated during actual operation. (The figure assumes a noise source, but there are many cases where surges are generated by the drive circuit. In this case, you can still detect the surge with this method.)



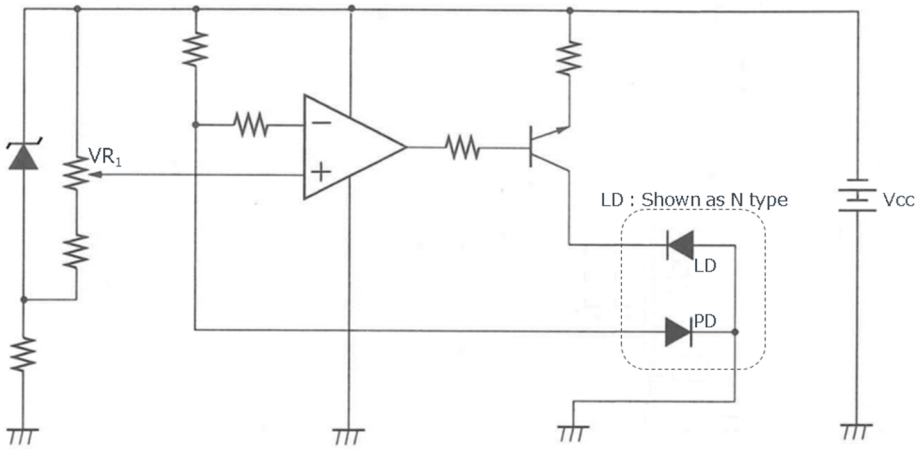
[Fig. 2-9]

Examples of surge destruction and measures

1.Overcurrent (inrush current) breakdown at the time of APC circuit mounting : Breakdowns due to transient characteristics at the rise of power supply



2. During the exchange of samples in the APC circuit, VR1 was lowered and LDs were exchanged in order to reduce the optical output to zero, but the exchanged LDs were destroyed by an overcurrent. When the previous LD was removed, the circuit became open and the output voltage rose to Vcc, which caused an overcurrent to flow to the next LD and destroy it.

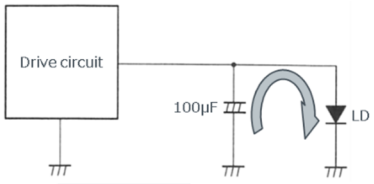


Measures Reduce output voltage before setting LD.

After lowering VR1 so that the light output becomes 0, Vcc is lowered so that the output voltage becomes 0, and then the LD is set.

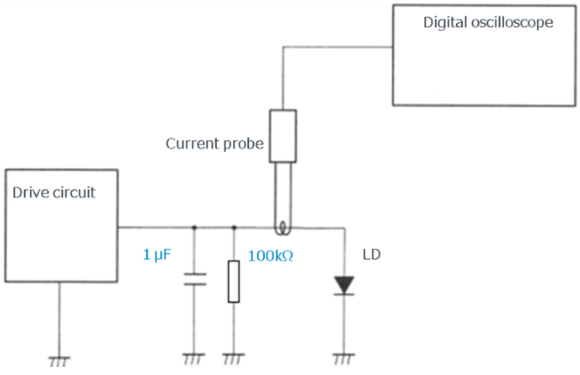
3. Destroyed because a large capacitor was connected to the drive power supply terminal.

: The voltage charged to the capacitor when the power supply is turned off causes current to be applied to the LD drive power supply terminals in reverse, resulting in an overcurrent breakdown.



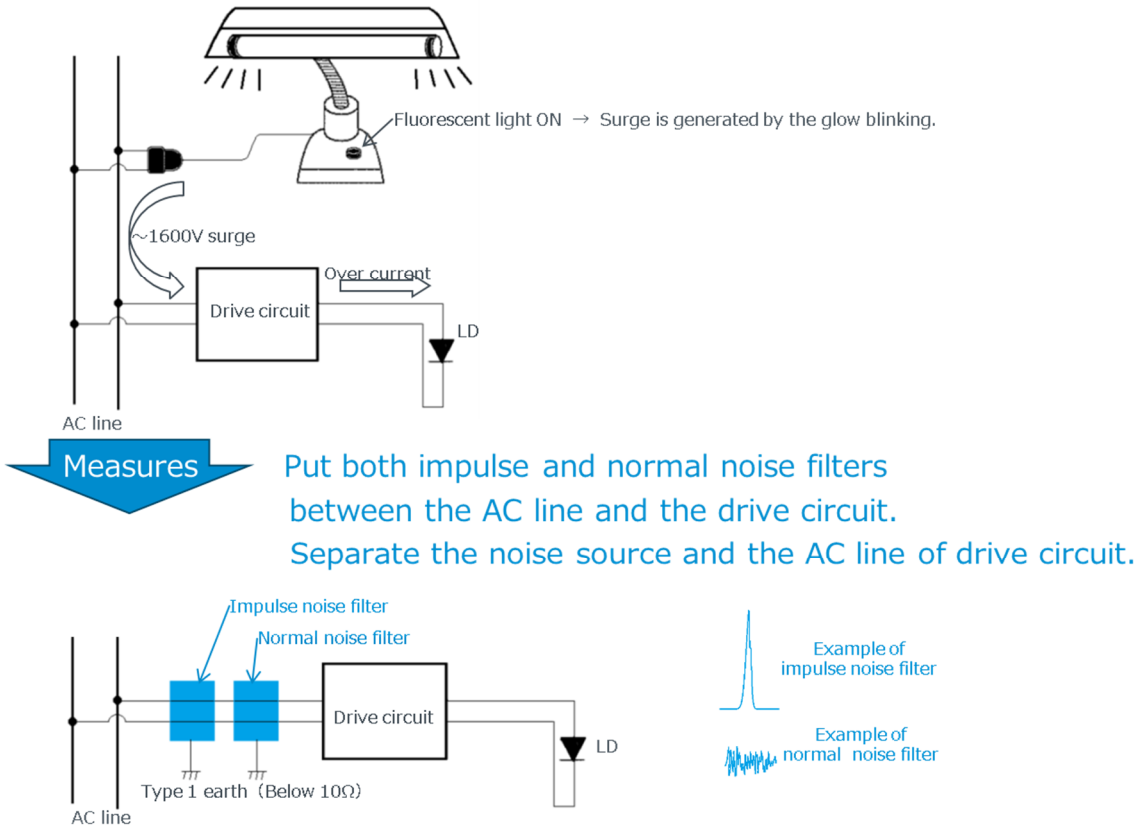
Measures

Optimize capacitor capacity.
Put a resister in parallel with the capacitor.
Check if transient surge is applied
when the circuit is ON/OFF.

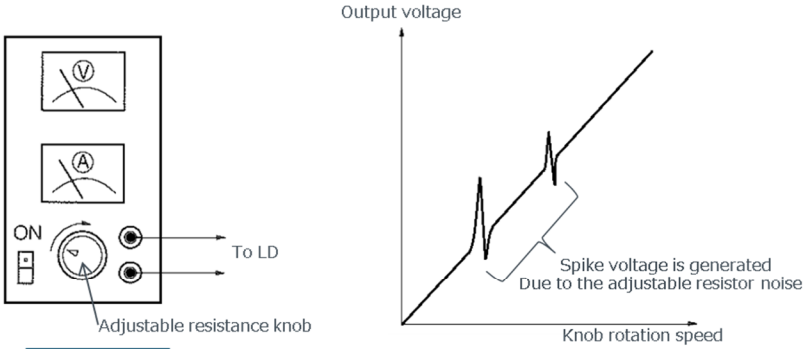


4. LDs were destroyed the moment the fluorescent lamp on the next seat was turned on during LD characteristics measurement.

: This is due to a surge of ~ 1,600 V in the common AC line when the fluorescent lamp is turned on and enters the AC input of the LD drive circuit.

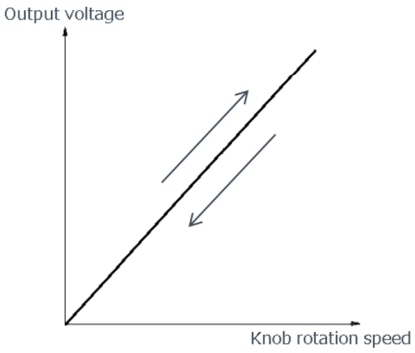


5. LDs were broken when the variable resistor was turned during the output adjustment of LDs. Overcurrent flowed and destroyed due to the skinny variable resistor.

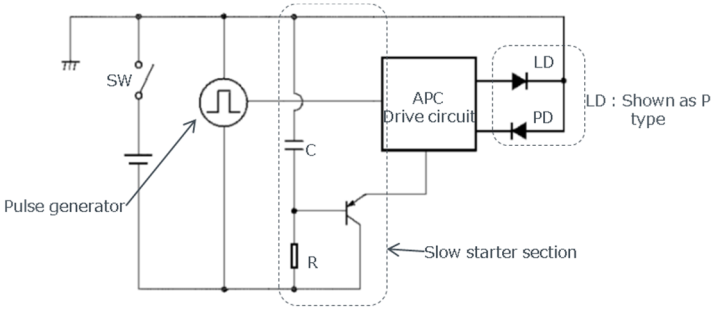


Measures

Replace the adjustable resistor regularly.
Check that there is no spike voltage by the oscilloscope.
Keep the process clean to avoid dust on the adjustable resistor

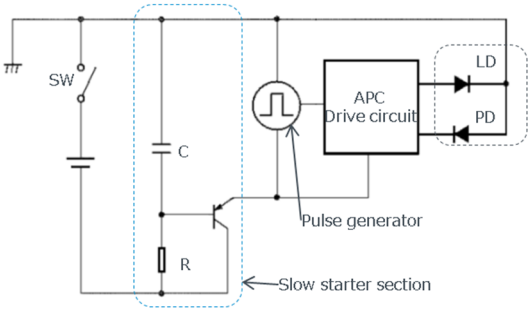


6. LDs were destroyed when the power SW was turned on in the circuit below.
A large time constant of the slow starter causes a delay in the rise of the APC, resulting in an overcurrent that destroys it.

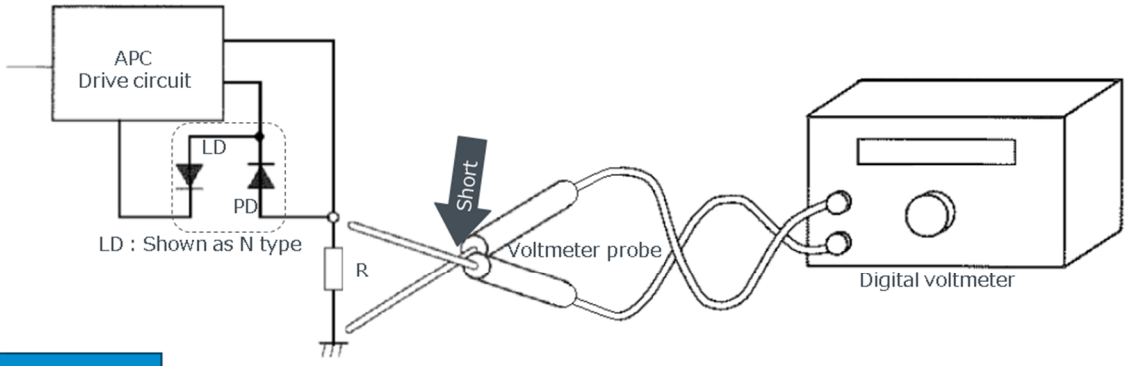


Measures

Pulse generator is set behind the slow starter section,
and rise and APC are occurred at the same time.

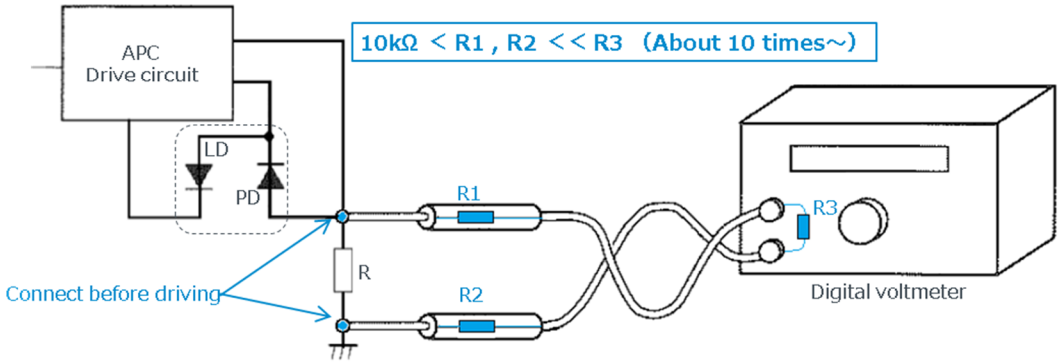


7. The LD was destroyed while measuring the monitor voltage in the APC circuit to check the light output. The probe of the voltmeter short-circuited each other and the monitor voltage became 0, which caused an overcurrent to flow to the LD. (In the figure below) A surge from the voltmeter may cause a decrease in the monitor voltage and an overcurrent to occur even without a short circuit.



Measures

Don't check by external contact while the APC circuit is driving.
Connect to the appropriate pins before driving.



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