Types of grounding and ground loops

Why there are multiple GND types:

In pcb it is recommended to have one single ground plane used to connect all grounds in the board but some components may have multiple different ground names on its pins like AGND,DGND,SGND,PGND these types of ground pins are very common in dc/dc converters , DAC , ADC and other components that usually require analog inputs , these ground classifications usually written by the manufacturer to notify the designer that these pins should be split between multiple ground planes and not connected to the same ground plane . this is usually done to prevent EMI , crosstalk and noise problems in the design.

Different types of grounding:

1. **GND (ground)**

   Purpose : This type of grounding is the general ground used as a reference point for the circuit and also provides the return path for all currents in the circuit , this one is the most used type of grounding among the other types

   Applications : usually the reference point for measuring voltages

2. **AGND (analog ground)**

   Purpose : this type of grounding used as a reference ground for all of the analog signals on the board whether these signals are inputs or outputs .

   Applications : used in ICs that deals with analog and digital signals to separate the analog portion from any noise that can happen in the digital portion of the circuits

3. **DGND (digital ground)**

Purpose : this type of grounding used as a reference ground for all of the digital signals on the board

Applications : used to provide a return path for digital signals on the board usually found in microcontrollers and digital ICs

4. **PGND (power ground)**

   Purpose : this type of grounding is used in power electronics and high current applications to provide a ground reference for components . also knows as **PRIMARY GROUND** in non-isolated switching regulators

   Applications : common in power supply and switching regulator and motor drives , these applications generally have high current output and can cause noise to other sensitive components in the circuit.

5. **SGND (signal ground)**

   Purpose : this type of grounding is used to provide a return path of low-level signal circuits . also knows as **secondary grounding** in non-isolated switching regulators

   Applications : used in high precision analog circuits to provide clean reference point

When to physically sparate different ground planes :

1.DC/CD CONVERTERS WITH (ISOLATED)

In this type of converters, the SGND & PGND grounding should be physically separated to maintain galvanic isolation between them

2.High SENSITIVITY CIRCUITS

In mixed-signal circuits where there is analog signals and digital signals in the same chip it is advisable to separate the AGND & DGND from each

other this will prevent high switching noise form digital signals to affect the analog signals.

3.RF HIGH FREQUECY CIRCUITS

Separating ground planes in these circuits helps reducing crosstalk and improve isolation between different sections of the circuit

When to connect different ground planes together :

1.DC/CD CONVERTERS WITH (ISOLATED)

In these types the SGND & PGND grounding can be connected at a single point

2.DC/CD CONVERTERS WITH (ISOLATED)

In this case using one solid ground plane is preferable as it provide stable reference point and reduce ground impedance , noise will not be a significant problem in these circuits

What is ground loops in pcb :

Ground loops is unintended current flowing in a closed loop at the ground plane. That usually happen when there are multiple ground connections with different electric potentials which makes the current circulate in the board and causing noise in electrical circuits. Ground loops also common with name (ground rings).

How to prevent ground loops :

Ground loops can never be eliminated but can be reduced using these techniques:

1.instead of connecting different point directly to the ground plane , it is advisable to route a trace from the points to the ground plane this will eliminate the change of having potential difference between ground points and forming ground loops

2. connecting the ground plane to the power supply at only single point instead of multiple points

3. placing ground plane under all signal traces, if possible, this will reduce the ground loops and improve signal integrity but it is only advisable in low frequency applications. As in high frequency applications placing ground planes under signal traces can create EMI problems.

4.Avoid routing traces over different ground planes , traces should be routed over it's ground planes only for ex if trace is carrying analog signals should be routed over SGND place and never cross it.