**Op Amps - Key Facts**

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| **Ideal Op Amp**  Summary-op-amp.gif | |
| Gain | Infinity |
| Input resistance | Infinity |
| Output resistance | Zero |
| Gain Bandwidth Product (GBP) | Infinity  Gain x Frequency = GBP |

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| **Comparator**  Summary-comparator.gif | |
| Gain | Infinity |
| Output | Always saturated high or low |
| Input Resistance | Infinity |
| Comparisons | * If V+ is greater than V- then the output is high. * If V+ is less than V- then the output is low. |

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| **Inverting Amplifier**  Summary-Inverting.gif | |
| Gain | * Gv = -Rf / R1 * Gv = Vout / Vin |
| Input resistance | R1 |
| Virtual Earth | Point P  Op Amps have a very high open loop gain so if the output is a few volts, the inverting input voltage will be a few microvolts. This is so close to zero, it is called a virtual earth. |

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| **Non Inverting Amplifier - Two Ways to Draw the Diagram**  Summary-Non-Inverting.gif Non Inverting - Alternative Diagram | |
| Gain | * Gv = 1 + Rf / R1 * Gv = Vout / Vin |
| Input resistance | The input resistance of the op amp which is roughly infinity. |

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| **Summing Amplifier**  Summary-Summing-Inverting.gif | |
| Calculate Vout | Vout = - Rf (V1/R1 + V2/R2 + V3/R3) |
| Input resistance | It's R1 for the V1 input and R2 for the V2 input etc. |
| Virtual Earth | The point P is the virtual earth. |

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| **Difference Amplifier**  Summary-difference-amplifier.gif | |
| Calculate Vout | Vout = ( V+ - V- ) x ( Rf / R1 ) |
| Input Resistance | 2 x R1 |

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| **Voltage Follower**  Summary-voltage-follower.gif | |
| Voltage Gain | The voltage gain is ONE. |
| Power and Current Gain | This can be very large. |
| Input resistance | Infinity |
| Output resistance | Small so usefully large currents can be provided. |
| **Schmitt Trigger**  Op Amp Inverting-Schmitt-Trig.gif   * On the left, a simple version with positive feedback giving different on and off reference voltages. * On the right is a comparator with one extra resistor giving positive feedback to give different on and off reference voltages. | |