Unit 114: Operational Amplifiers

Unit code: K/602/2233  
QCF Level: 4  
Credit value: 15

Aim
This unit will extend learners understanding of the characteristics of operational amplifiers and will develop the skills needed to design and build operational amplifier circuits and active filters.

Unit abstract
In this unit learners will investigate the operational amplifier and develop an understanding of their industrial applications. The unit is self-contained, presenting an overview of the device and providing all the necessary background theory and circuit design. The intention is to provide an insight into the applications aspects of the operations amplifier, which learners can then build on in other units and further study.

Learning outcomes
On successful completion of this unit a learner will:
1 Understand the characteristics and parameters of operational amplifiers
2 Be able to design, build and test operational amplifier circuits
3 Be able to design an active filter to meet a given specification
Unit content

1 Understand the characteristics and parameters of operational amplifiers

*Characteristics:* input and output impedance; voltage gain; common mode rejection ratio; input bias; offset currents; unity gain bandwidth; slew rate; differential input range; full power bandwidth; drift; constant current source

*Parameters:* determine practically for common operational amplifier types the open loop gain-bandwidth product and the slew rate, offset voltage and offset current for operational amplifiers

2 Be able to design, build and test operational amplifier circuits

*Amplifier circuits:* derive gain equations for inverting and non-inverting amplifier circuits

*Design, build and test:* inverting, non-inverting, buffer, differential and summing amplifier circuits; this should be supported by software simulation of the designs, which should be tested to produce full specifications including gain, phase shift and roll-off characteristics; level shifter

*Compensation:* internal and external compensation of an operational amplifier; corner frequencies and roll-off rates; determine the effects on frequency of single-pole, double-pole and feed-forward compensation when applied to a suitable operational amplifier

*Typical applications circuits:* eg compensator, current-to-voltage converter, integrator, differentiator, Schmitt trigger and oscillator (RC relaxation or Wien Bridge type); to include mathematical modelling, computer simulation and practical investigation where appropriate

3 Be able to design an active filter to meet a given specification

*Filter:* filter types (Bessel, Butterworth, Chebyshev, Sallen and Key); phase; attenuation characteristics for low-pass, high-pass and band-pass types; design of active filters to generate appropriate response functions

*Specifications:* design and test a controlled-source filter to produce a low-pass response that meets given specification, involving calculations and software simulation in addition to practical construction and testing
## Learning outcomes and assessment criteria

<table>
<thead>
<tr>
<th>Learning outcomes</th>
<th>Assessment criteria for pass</th>
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<tbody>
<tr>
<td><strong>On successful completion of this unit a learner will:</strong></td>
<td><strong>The learner can:</strong></td>
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<tr>
<td><strong>LO1</strong> Understand the characteristics and parameters of operational amplifiers</td>
<td>1.1 explain the various ‘ideal’ characteristics of the operational amplifier</td>
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<td>1.2 measure the open loop gain-bandwidth product of a common operational amplifier and common parameters for a range of devices</td>
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<tr>
<td><strong>LO2</strong> Be able to design, build and test operational amplifier circuits</td>
<td>2.1 derive gain equations for amplifier circuits</td>
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<td>2.2 design, build and test common amplifier circuits</td>
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<td>2.3 describe ‘compensation’ as applied to operational amplifiers</td>
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<td>2.4 determine the operation and characteristics of an operational amplifier when used in two typical applications</td>
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<td><strong>LO3</strong> Be able to design an active filter to meet a given specification</td>
<td>3.1 describe types of filter</td>
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<td>3.2 design an active filter to meet the requirements of a given specification and test for conformance to specification</td>
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Guidance

Links
This unit can be lined to *Unit 1: Analytical Methods* and *Unit 66: Electrical, Electronic and Digital Principles*.

Essential requirements
Learners will require access to appropriate software packages to predict outcomes and simulate circuit performance.

Employer engagement and vocational contexts
Delivery of this unit will benefit from centres establishing strong links with employers willing to contribute to the delivery of teaching, work-based placements and/or detailed case study materials.