khs instruments

analog::blocks

OpAmp Module Configurations

Application Note

Rev. 1.0

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1. Introduction

The analog::blocks OpAmp module provides a pre-routed circuit board with multiple component positions, allowing a wide range of amplifier configurations without designing a new PCB.

At first glance, the number of resistor and capacitor positions may appear unnecessarily complicated. However, most applications require only a few components.

The following examples demonstrate how different amplifier circuits can be realized simply by selecting the appropriate component positions.

The examples are intended to illustrate the flexibility of the module rather than to explain the fundamentals of operational amplifier circuits.

2. Basic Schematic of the OpAmp Module

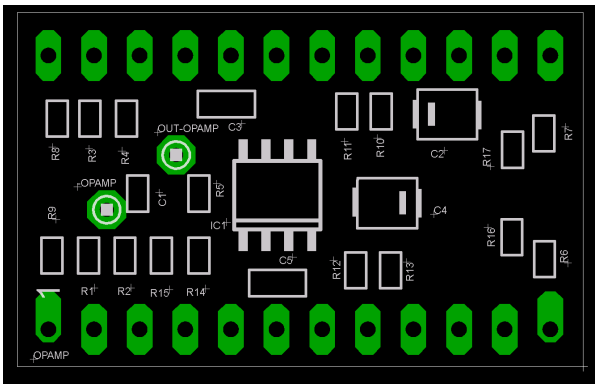


Figure 1: Common SO-8 OpAmp Board layout Version 2.0

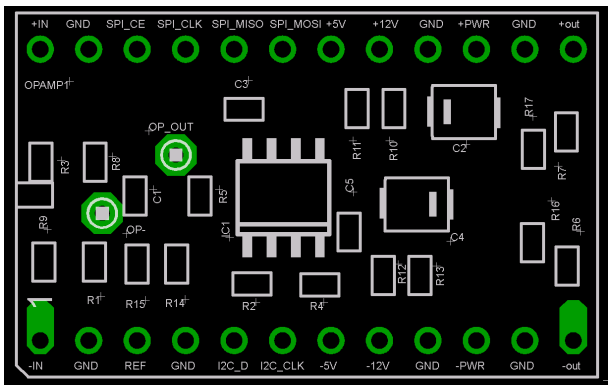


Figure 2: Common SO-8 OpAmp Board layout Version 2.1

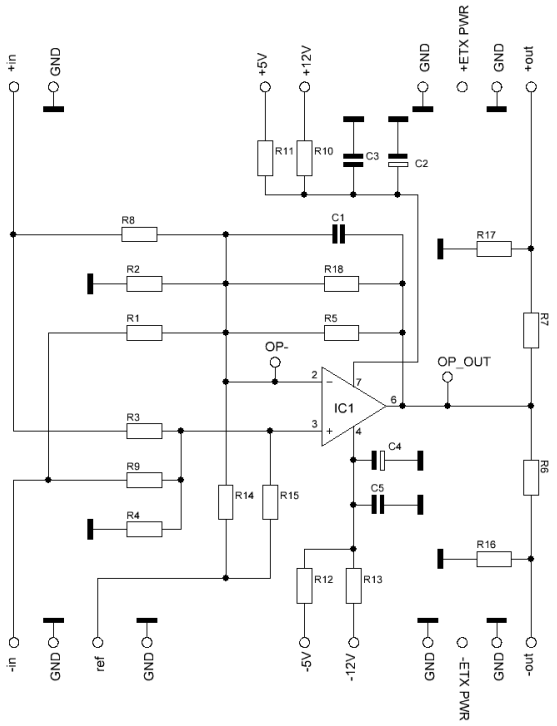


Figure 3: Common OpAmp circuit.

Components / pads	Function
R1 / R2 / R8	Configuration of the inverting (-) OpAmp input
R3 / R4 / R9	Configuration of the non-inverting (+) OpAmp input
R5 / C1	OpAmp Feedback configuration
R18	OpAmp Feedback on the solder side, version 2.1 only
R14 / R15	Connection to the application-defined REF input
-OPAMP / OUT-OPAMP	Through-hole pads for external feedback components
R6 / R16, R7 / R17	Output routing
R10 / R11	Positive supply selection: +5 V or +12 V
R12 / R13	Negative supply selection: -5 V or -12 V

3) Configuration Notes

The PCB supports non-inverting, inverting, differential and transimpedance amplifier configurations by changing the resistor population.

3.1) Selecting ±5 V Power Supply: Populate R11 and R12 and remove R10 and R13.

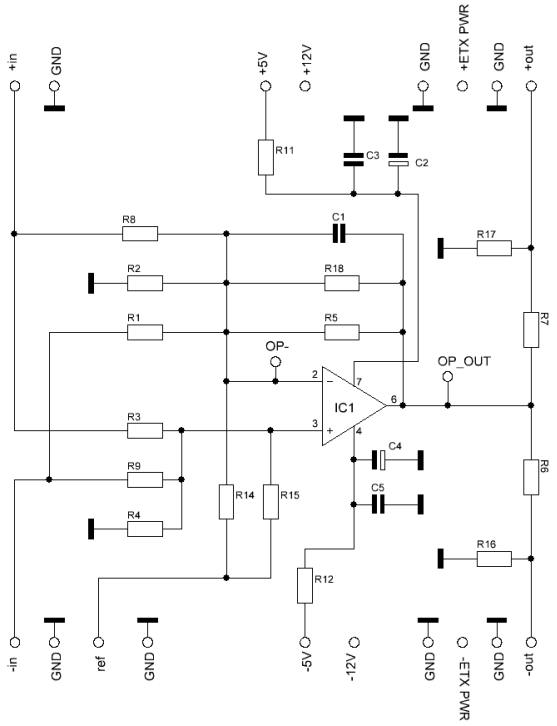


Figure 4: ±5 V Power Supply configuration.

3.2) Selecting ±12 V Power Supply:

Populate R10 and R13 and remove R11 and R12. Ensure that C2 and C4 have sufficient voltage ratings.

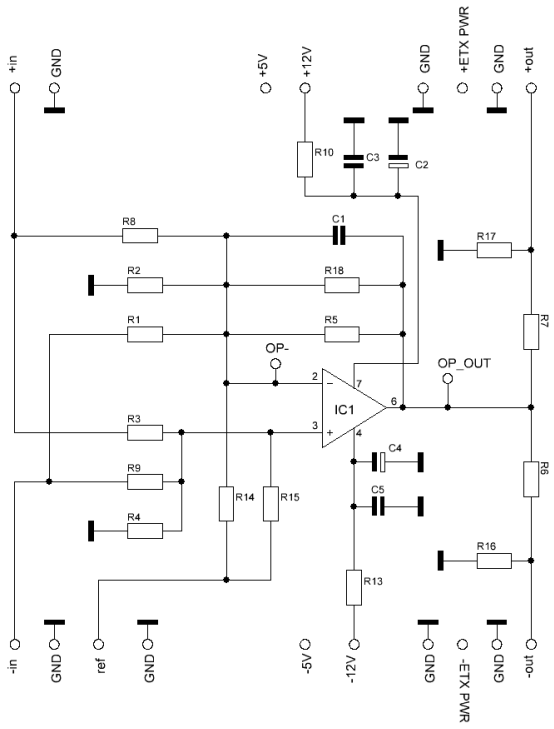


Figure 5: ±12 V Power Supply configuration.

3.3) Single 5 V Power Supply:

Populate R11, C2, C3. Remove R10, R12 and R13 and C4 and C5. Solder a 0 Ohm resistor instead of C5.

You may use R14 / R15 instead of R2 / R4 together with a ref voltage as virtual ground.

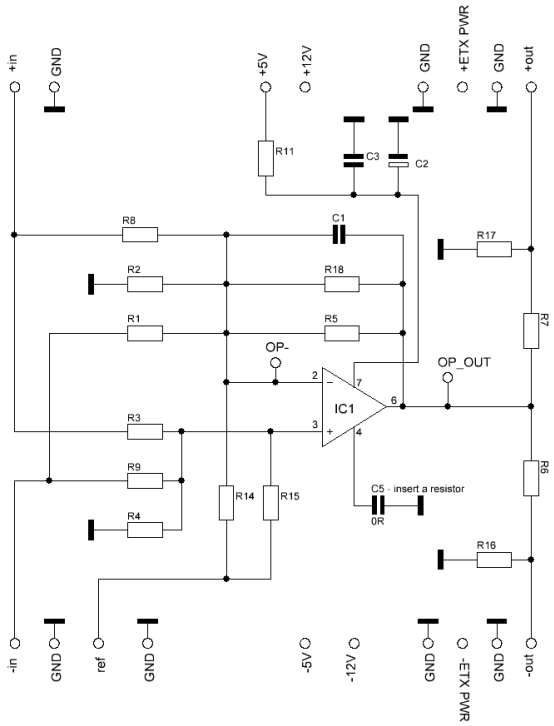


Figure 6: +5 V Single Power Supply configuration.

Note: For clarity, the power supply circuitry is omitted from the following schematics. Only the components relevant to the particular amplifier configuration are shown. All other component positions remain unpopulated unless otherwise specified.

3.4) Non-inverting amplifier with +in input and +out output :

The input signal is applied to the non-inverting input via the +in input via R3 / R4. R2 and the feedback resistor R5 or R18 determine the voltage gain. C1 may be used to limit the bandwidth.

Additional feedback can be be inserted via the OP- and OP_OUT THT pins. A voltage divider R7 / R17 may be inserted if required. When required R14 or R15 can be used if a global reference voltage is provided.

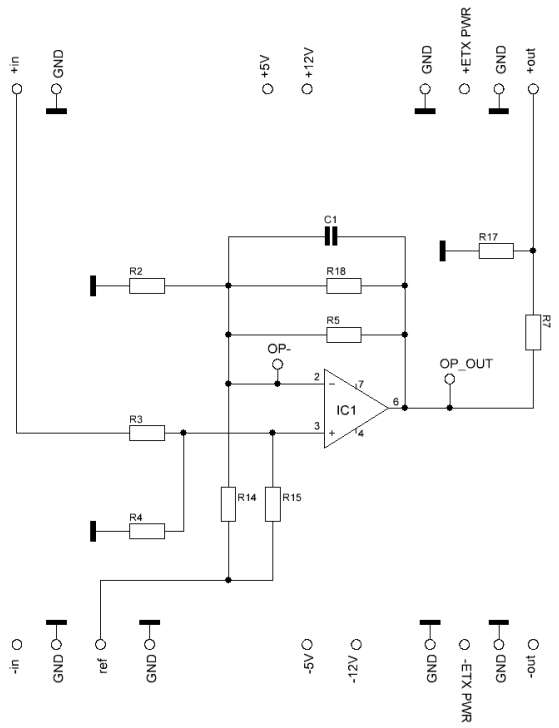


Figure 7: Non inverting Amplifier from +in to +out.

3.5) Non-inverting amplifier with -in input and -out output :

The input signal is applied to the non-inverting input via the -in input via R9 / R4. R2 and the feedback resistor R5 or R18 determine the voltage gain. C1 may be used to limit the bandwidth.

Additional feedback can be inserted via the OP- and OP_OUT THT pins. A voltage divider R6 / R16 may be inserted if required. When required R14 or R15 can be used if a global reference voltage is provided.

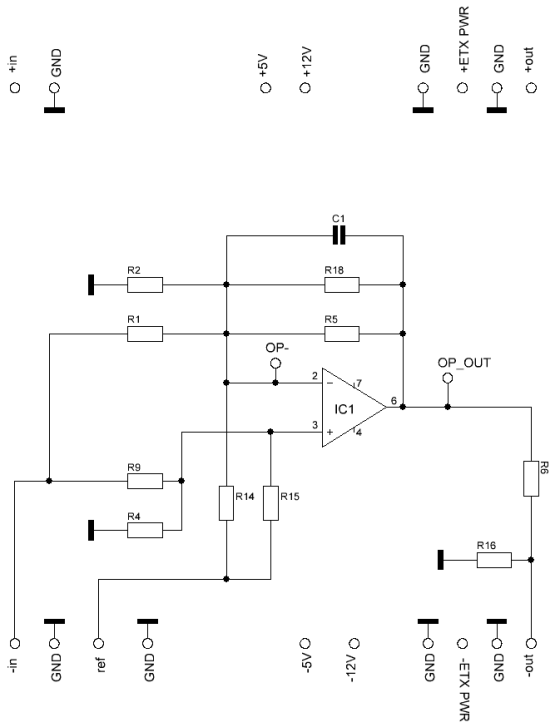


Figure 8: Non inverting Amplifier from -in to -out.

3.6) Inverting amplifier with +in input and +out output :

The input signal is applied to the inverting input via the +in input via R8. R8 and the feedback resistor R5 or R18 determine the voltage gain. C1 may be used to limit the bandwidth.

Additional feedback can be inserted via the OP- and OP_OUT THT pins. A voltage divider R7 / R17 may be inserted if required. When required R14 or R15 can be used if a global reference voltage is provided.

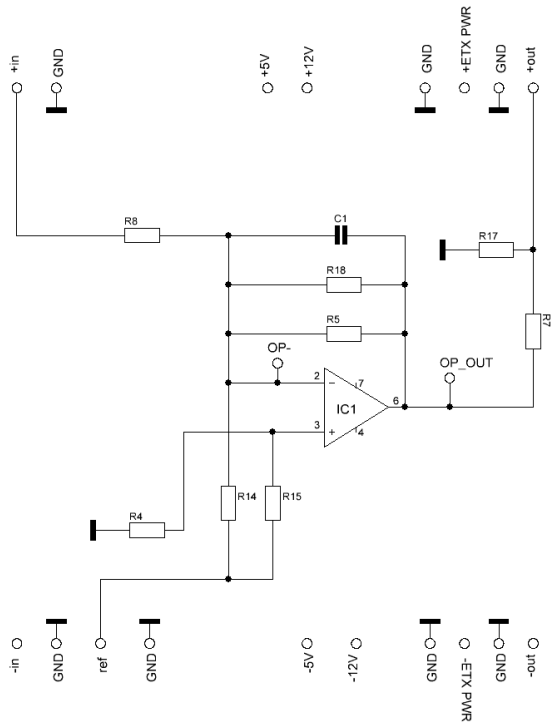


Figure 9: Inverting Amplifier from +in to +out.

3.7) Inverting amplifier with -in input and -out output :

The input signal is applied to the inverting input via the -in input via R1. R1 and the feedback resistor R5 or R18 determine the voltage gain. C1 may be used to limit the bandwidth.

Additional feedback can be inserted via the OP- and OP_OUT THT pins. A voltage divider R6 / R16 may be inserted if required. When required R14 or R15 can be used if a global reference voltage is provided.

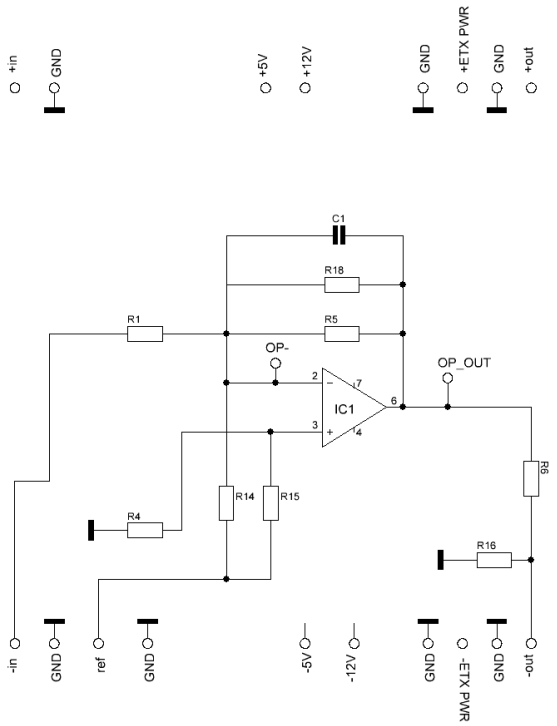


Figure 10: Inverting Amplifier from -in to -out.

3.8) Differential amplifier with +in and - in input and +out output :

The -in signal is applied to the inverting OpAmp input via R1, while the +in signal is applied to the non-inverting input via R3. For proper differential operation, the resistor ratios R5 / R1 and R4 / R3 should be equal.

R1 and the feedback resistor R5 or R18 determine the voltage gain. C1 may be used to limit the bandwidth.

Additional feedback components can be connected via the OP- and OP_OUT through-hole pads. A voltage divider using R7 / R17 may be added if required.

If a global reference voltage is available, R14 or R15 can be used instead of R4.

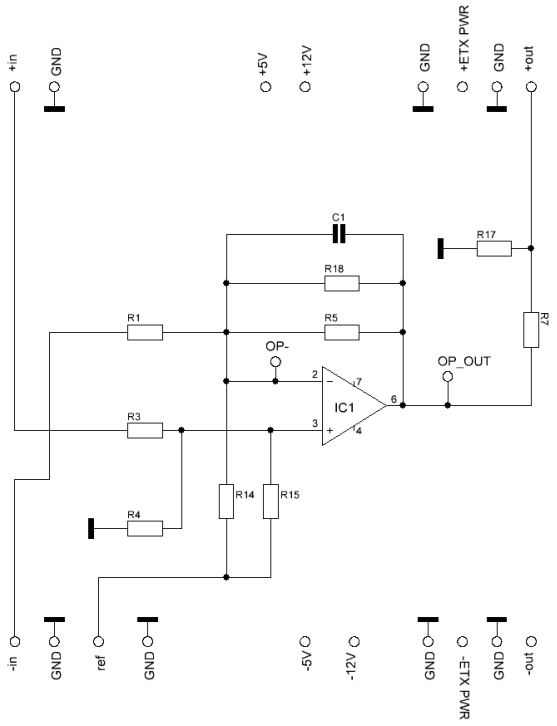


Figure 11: Differential Amplifier to +out.

3.9) Transimpedance amplifier with +in input and +out output with GND reference:

The input signal is applied to the inverting input via the +in input via R8 = 0 Ohm. So the feedback resistor R5 or R18 determine the current to voltage gain. C1 may be used to limit the bandwidth.

Additional feedback like a small ceramic capacitor can be inserted between the OP- and OP_OUT THT pins. A voltage divider R7 / R17 may be inserted if required.

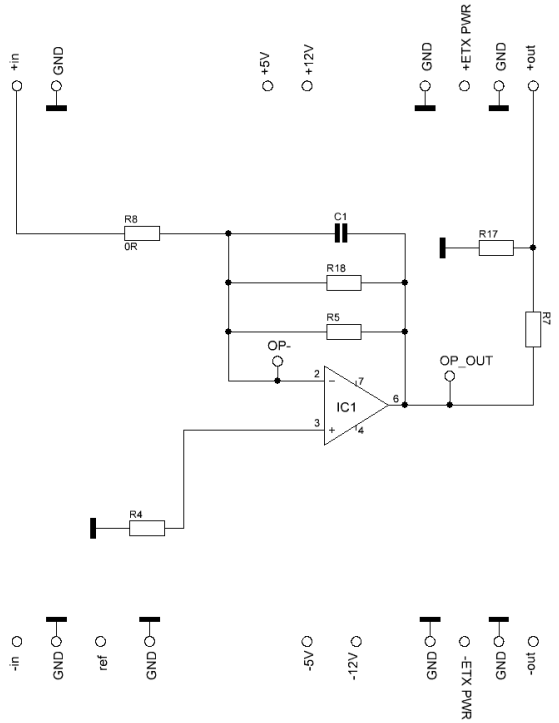


Figure 12: Transimpedance Amplifier to +out with GND reference.

3.10) Transimpedance amplifier with +in input and +out output with ref reference:

This configuration may be used in the case there is only a single supply.

The input signal is applied to the inverting input via the +in input via R8 = 0 Ohm. So the feedback resistor R5 or R18 determine the current to voltage gain. C1 may be used to limit the bandwidth.

Additional feedback like a small ceramic capacitor can be inserted between the OP- and OP_OUT THT pins. A voltage divider R7 / R17 may be inserted if required.

The reference input is connected to the -in input so it serves as ref output, so e.g. a photodiode can be connected to the -in terminal and the +in terminal. R4 can be replaced by a capacitor lowering high frequency impedance of the -in terminal.

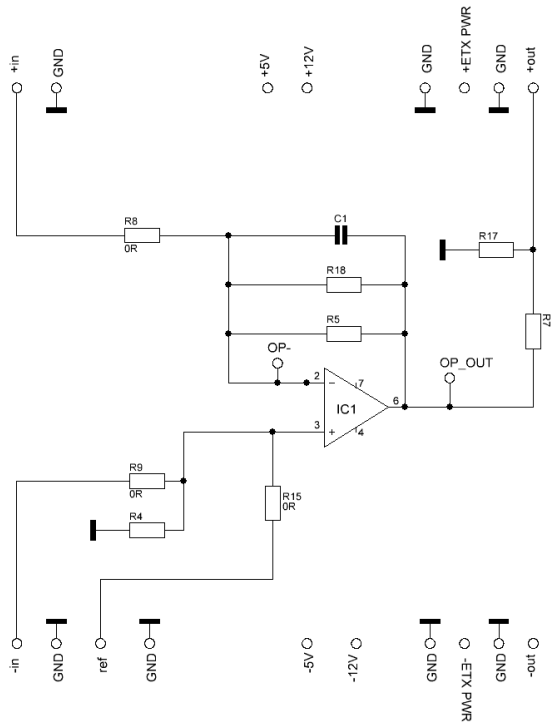


Figure 13: Transimpedance Amplifier to +out with ref reference.

3.11) Expanding the opamp feedback via +in and +out.

In some applications, such as active filters, the required feedback network is more complex than can be implemented using R9, C1 and R5 alone like in Fig. 3.12 in the "application of linear microcircuits" from August 1967, section 3.1.12 Band-Pass Amplifier.

In such cases, the feedback network can be extended to a second module, such as a prototype board or a Transmission Line Module. The latter provides controlled-impedance signal paths, making it particularly suitable for investigating high-frequency feedback networks.

Figure 14 shows an example of a bandpass amplifier with the feedback network mounted on a second module. R7 and R8 are 0 Ohm resistors. C1 may be required for stability.

The input signal is fed to the +in input of the feedback module. The +in and -in terminals, as well as the +out and -out terminals, are connected in pairs by jumpers on the Base Board.

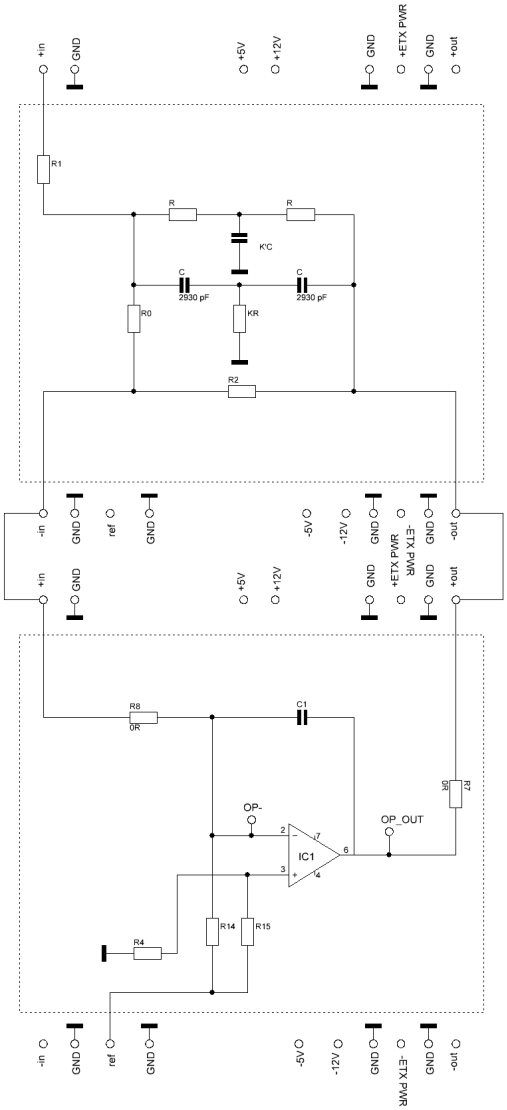


Figure 14: Bandpass Amplifier with external feedback module.

4. Conclusion

The analog::blocks OpAmp module provides a flexible platform for developing and evaluating operational amplifier circuits. By changing only a few components, a wide range of amplifier configurations can be implemented without designing a new PCB.

Together with the analog::blocks Base Board, individual amplifier modules can be combined into more complex analog signal processing circuits. This allows different operational amplifiers, circuit configurations and feedback networks to be evaluated in a common modular environment.

More complex feedback networks can be implemented on additional modules, including prototype boards and Transmission Line Modules. The latter provide controlled-impedance signal paths, allowing high-frequency effects and parasitic influences to be investigated systematically.

History:

Revision	date yy/mm/dd	Changes
1.0	26/11/11	Initial.