

Constant Current Add on card for Xgen platforms.

Abstract: The Xgen is designed to supply a constant voltage to the customer load. In recent times there has been a demand for using the Xgen platform as a constant current supply. In response to this the Excelsys Applications Engineering team have designed an external add on card to allow the user to use the Xgen platform in such a mode.

PowerMod trim operation:

The Xgen series of products have been designed to allow maximum flexibility in meeting the unique requirements of individual users. The inherent flexibility resulting from modularity concepts is further enhanced by this flexibility. This flexibility can be further enhanced by using the Xgen platform as a constant current source. This can be achieved by incorporating the voltage adjustment feature on the J3 connector to set the unit to a voltage which results in the correct current being delivered to the load.

Voltage Adjustment:

With regards to voltage adjustment this flexibility has been achieved by the wide range of adjustment on each of the powerMod models. Voltage adjustment may be achieved by:

1. Front-panel potentiometer adjustment
2. Remote resistive programming
3. Remote voltage programming

See Figure 1 below for details on external connections to the V trim pin (J3 pin3) required for remote voltage programming.

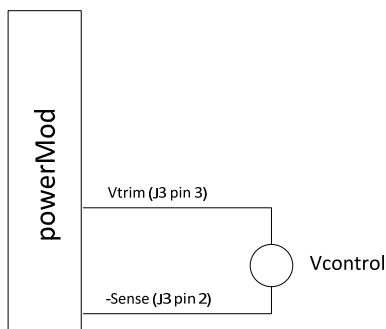


Figure 1: Remote Voltage Programming

Remote Voltage Programming using a Voltage Source:

Using an external Voltage source ($V_{control}$), the powerMod output voltage may be adjusted over a wide range. The powerMod output voltage may be programmed by referring to the Voltage Programming graph and applying formula below to set the powerMod output voltage to the required level.

$$V_{output} = K \times V_{control} \quad (1)$$

The appropriate K factor for different powerMods are in Voltage Programming table in Figure 2 below.

Important: $V_{control}$ must not exceed 2.5V. Otherwise the Over voltage protection feature on the PowerMod will be triggered and the power supply will be latched off. E.g. V_{nom} of Xg3 is 12V, trim range is 3.6V to 15.0V. While this will not damage the power supply, it will require the user to power cycle the mains in order to turn the unit on again.

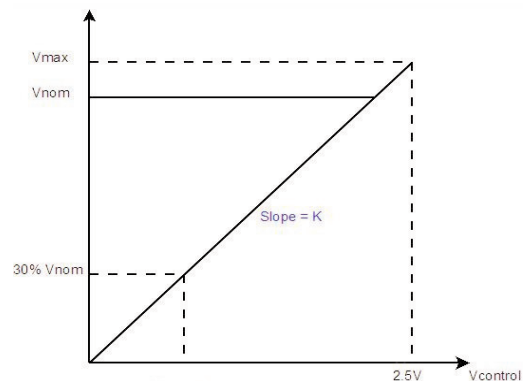


Figure 2: Voltage Programming

PowerMod	K
Xg1	1.5
Xg2	2.5
Xg3	6.25
Xg4	12.5
Xg5	24.25

Fig 3: K Factors of PowerMods

Constant Current Adjustment:

Utilising external circuitry and the voltage adjustment method described above, the Xgen powerMod may be used as a constant current source. The external circuitry is shown in Figure 4 below:

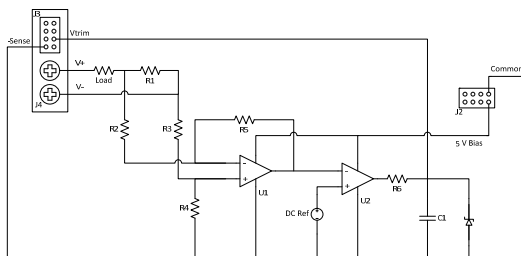


Figure 4: Constant Current Circuit

Theory of Operation:

A current sense resistor (R1) is connected in series with the load to be powered by the powerMod. The voltage drop across this current sense resistor is proportional to the current flowing through it; however, this voltage drop will be very small and will need to be amplified in order to be used to control the Vtrim signal.

The op-amp U1 is used as a differential amplifier, and the resistors R2, R3, R4 and R5 set the gain of this amplifier. The gain should be selected so that the maximum current required by the application will result in the maximum possible voltage output (of upper voltage rail) from the op-amp (see op-amp datasheet for this value). The following formulae should be used once the R1 value has been selected and the Max Current determined:

$$\frac{R4}{R2} = \frac{Op\text{-amp max output}}{Max\ Current * R1}$$

$$R2 = R3$$

$$R4 = R5$$

U2 is used as a comparator, and compares the output U1 (a voltage representation of the current flowing through the load) with a DC reference which sets the desired current output of the module.

If the DC reference is higher than the output of U1, the output of U2 is pulled to ground, and capacitor C1 is discharged, reducing the voltage at Vtrim, which reduces the output voltage, reducing the current flowing through the load.

If the DC reference is lower than the output of U1, the output of U2 will be pulled to the upper rail, and the capacitor C1 is charged, increases the voltage at Vtrim, which increases the output, increasing the current flowing through the load.

The loop is now closed and the DC reference and external circuit controls the constant current through the load. The DC reference can easily be set using the 5 V bias supply in a potential divider circuit removing the requirement for an external DC reference.

The Zener Diode Z1 should be chosen to ensure that the Vtrim voltage does not go above 2.5 V (the maximum value that should be applied to the Vtrim pin). The value of R6 is chosen in conjunction with the modules potentiometer setting to set the modules Vtrim range. This is because the resistor R6 and the potentiometer form a potential divider that sets the voltage reference for the main error amplifier circuit.

Worked Example

The following example shows an application where the Xgen is used in a constant current mode of operation in order to drive a constant current through a heating element that's resistance changes with respect to its temperature.

The heating elements initial resistance is around 6 Ω , and the constant current required is 3.3 A. The application also required scope for two elements to be connected in series. The requirements of this application are therefore:

Constant Current Output:	3.3 A
Lower Voltage Limit:	16 V
Upper Voltage Limit:	39.6 V

A 2 m Ω resistor was chosen as the current sense resistor, and 1 k Ω was chosen for R2 and R3. Finally, a dual op-amp (LM2904) with an upper rail of approximately 3.75 V was used. If a maximum output current of 4 A chosen it will

provide some scope to trim the current higher if required. Using the formula given earlier in this document:

$$\frac{R4}{R2} = \frac{Op - amp\ max\ output}{Max\ Current * R1}$$

$$\frac{R4}{1k} = \frac{3.75}{4 * 0.002}$$

$$R4 \approx 470\ k\Omega$$

With these resistance values, the DC reference required to give 3.3 A can be calculated as follows:

$$DC\ Ref = \frac{Current * R1 * R4}{R2} = \frac{3.3 * 0.002 * 470k}{1k} = 3.102\ V$$

A 47 uF capacitor was chosen for C1, which gives a stable output. A smaller capacitor value will result in a more responsive circuit.

Finally we must choose the resistor R6 and the potentiometer set point. This can be done through trial and error and depends upon the choice of op-amp, the set-point of the on-board potentiometer and the value of R6 (the lower the value of R6, the wider the constant current range, the setting of the on board potentiometer will set the median of the constant current range). This can be done through trial and error (a good starting point is nominal voltage for the pot, and 9.1 kΩ for R6).

The completed circuit for this application is shown in Figure 5 below:

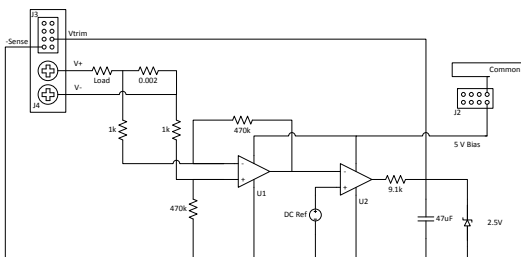


Figure 5: Constant Current Circuit

Due to the nature of this circuit, an overshoot occurs during start-up. This is the case because on all occasions the 5 V bias voltage comes up before the module output voltage. As a result the constant current circuit will be operating before any output voltage is present. Without any feedback voltage present, there will be no current flowing through the load. The constant current circuit will therefore

try to increase the voltage at the Vtrim pin (by charging C1) to increase output voltage. When the output voltage eventually come up, the voltage at the Vtrim pin will be at its max, resulting in a high voltage across the load, generating a large current through the load.

The circuit will now sense the high current and will act to reduce the Vtrim voltage by discharging the capacitor C1 until the output current meets its set-point, at which point the module will output a constant current.

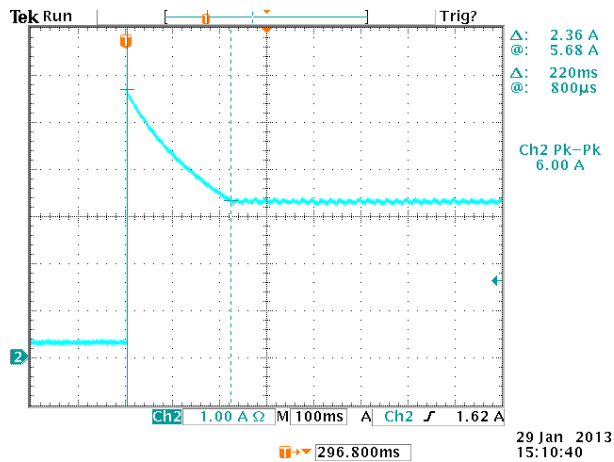


Figure 6: Overshoot on mains start up

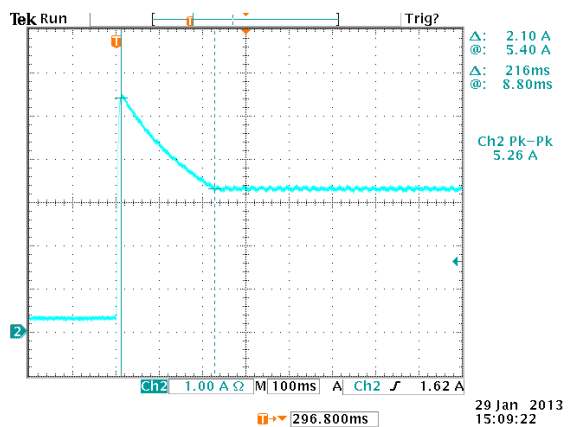


Figure 7: Overshoot on enable

In a more sensitive application, this overshoot can be reduced if required. The duration of this overshoot depends on the length of time it takes to discharge the capacitor C1. This can be shortened

by reducing C1's capacitance. As mentioned previously, the peak of this can be set by the selection of R6, or by carefully considering Z1 which limits the max voltage at Vtrim. These are trade off of course , and will limit the current trim range, so it is important to consider these points carefully.

In summary:

In summary, if you are designing a system which requires the Xgen to be used as a constant current supply, the external circuit as described above can be implemented. In order to ensure the optimum solution we would advise to contact support@excelsys.com to discuss any opportunity in detail with our technical team.

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