

## SM2050 SERIES DC-DC CONTROLLERS

MODEL SM2050P (DC-DC Switch mode Controller---common positive)  
SM2025P



Made in  
Australia



FRONT PANEL CONTROL

REAR PANEL MODULE

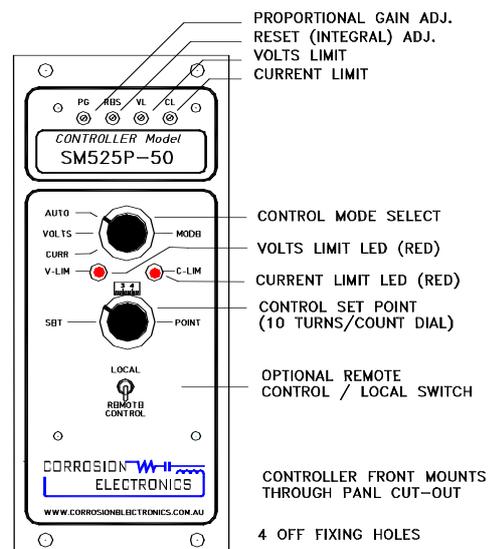
### 1. GENERAL DESCRIPTION

- The SM2050 controller is intended for applications where Solar / Battery DC power is predominantly available.
- If Galvanic isolation is required between the battery supply and CP load, an isolating DC power supply must be used
- These controllers employ P.W.M. (Pulse width modulation) of FET transistors at nominally 45 KHz. The FET transistors are rated to 200V. It is possible at this voltage rating to provide reasonable protection against lightning induced transients using appropriately rated surge suppression devices.
- This range of controllers has a **maximum output of 20A and 50V DC.** **The output voltage and current ranges need to be specified.**

- The common Positive model (**SM2050P**) has the controlling devices in the negative line and suits applications where multiple controllers share a common anode bed. Typically, this will be for pipelines where a common anode bed will service two (2) T/R's either side of an isolation joint (IJ).

## 2. MAIN FEATURES and OPTIONS

- Easy to replace in the field. Front module: (4 front screws and plug/socket wiring). Rear panel module: DIN rail mount with screw connections to 4mm.
- Multiple controllers can be powered from a single DC source
- Three selectable modes of control: voltage, current, reference potential.
- 10 turn control set point with turns counting dial
- Independent current and voltage limit set points with LED indicators
- Proportional gain and Integral potentiometers to allow for loop stability optimisation under any likely load condition.



- OPTIONAL (Specify if required) Remote control input. Requires 0-10V isolated (floating) signal.
- OPTIONAL Interrupt freeze input---interfaces to DC output switch module ([INT6](#)). This allows the output to be switched ON and OFF in any control mode with minimal current surging. This option is particularly good with DCVG type Interruption on pipelines.
- Output ripple is typically < 10mV.
- Input / Output Efficiency is typically 90% at full load
- Slow start on Power-up
- On board DC input fuse and DC output fuse
- On board HV surge protection on DC output lines
- Structure / reference control input impedance >1000 mega ohm to prevent loading the reference cell under dry soil conditions
- Minimum current Control resolution
  - 20mA in 20 amps range for 50V power input
  - 10mA in 20 amps range for 24V power input

- Current control resolution can be improved significantly if a dual shunt range is implemented.

### 3. Input voltage ranges

SM2012P      Input voltage range 13-20V (Nominally 12VDC)

SM2025P      Input voltage range 19-31V (Nominally 24VDC)

SM2050P      Input voltage range 38-60V (Nominally 48VDC)

The maximum output voltage on each range is  $V_{in} - 1.5V$

### 4. Size and layout – Rear panel module

This module mounts to a vertically aligned DIN rail

265mm high x 115mm wide

## OPERATION

### 1. Initial start-up

1.1 Before energising the controller for the first time, a physical check of connected wiring should be made. It is possible that some wires may have become displaced during shipment. All plugs and sockets are matched in such a way that only the correct plug will fit into a particular socket.

1.2 It is wise to commence with zero output (set point fully anti-c/w) in current mode and local control selected if included.

1.3 Slowly wind the set point clockwise (C/W) while observing the output volts, output amps and structure to reference potential. Two scenarios are likely.

(a) The desired structure to reference potential will establish instantly. This is typical of pipelines and well coated structures. In this event, proceed to Step 2.

(b) The reference potential may not shift enough initially and may require some hours, days or weeks to polarise.

**NOTE:** Different applications require particular polarising strategies, for example, concrete rebar protection which requires that the rebar must be progressively polarised over a 28 day period.

1.4 In the case of (a), discontinue increasing the output current when the desired reference potential is attained. At this point, it would be reasonable to set up AUTO reference control with current and voltage limits as detailed in step 2 & 3

In the case of (b), follow the **prescribed commissioning procedures** if the application is **concrete rebar protection**.

For **other bare steel** applications, the polarisation needs to be conservatively achieved without over-protection. This can be done in two ways,

(i) Select an appropriate current and voltage suitable for the anode material and **frequently** monitor the reference potential. Note that in constant current mode, the voltage will rise as the structure polarises. Conversely, if the control is set to voltage mode, the output voltage will remain constant and the current will reduce as the structure polarises.

(ii) Switch to AUTO control and adjust the set point to the desired potential. Set the current and voltage limits to an appropriate level. As the structure approaches the set potential, the current and voltage will automatically reduce to maintain the set potential. See step 2 & 3

## 2. Set Current & Voltage Limits

2.1 These limits are user set using a small screwdriver. The trimpots are labeled CL and VL and are located at the top of the controller front panel. If the current or voltage output exceeds these set points, the control is over-riden to prevent the output exceeding the pre-set levels. These are important adjustments for the following reasons based on the following control modes.

### Voltage Control.

In constant voltage control, the current will change due to changes in the external loop resistance. Some field conditions may cause the current to increase markedly which may cause over-protection. By setting the current limit to an appropriate value, the protection levels will be safe guarded.

### Current Control.

In constant current control, the voltage will change due to changes in the external loop resistance to maintain the output current at the set level. Some field conditions may cause the voltage to increase markedly which may exceed the maximum voltage rating of particular anodes. By setting the voltage limit to an appropriate value, the integrity of the anodes will be safe guarded.

### Auto (Potential) Control.

In auto potential control, setting both limits is important for the same reasons. If the reference electrode fails or is damaged, the only protection against over-protection is to set both limits to a safe level, particularly the current limit.

2.2 The setting for the current limit can be adjusted as follows:

(i) Take note of the main set point position for whichever control mode is in play. Increase the output current by winding up the main set point to a current that produces the most negative structure / reference potential that you are prepared to tolerate.

(ii) This current value is the “limit point” at which the current limit should operate. Using a small screwdriver, turn the CL trimpot slowly anti-c/w until the current limit LED just energises at the established “limit point”.

(iii) Restore the main set point to the originally noted position. The current limit has now been set to activate at the current which will hold the reference potential at the most negative structure / reference potential that you are prepared to tolerate.

**NOTE: For structures that are subject to severe telluric effects, it is common practice to allow the current to increase to a higher level to control the positive structure to soil shifts.**

### **NOTE:**

**The current limit should be fine tuned after the structure is fully polarised.**

2.3 Similarly, the voltage limit can be set the same way. The voltage limit setting will be based on the maximum allowable voltage for the anodes being used and the need to cater for very changeable soil or water resistivities. It may not be possible to wind up the voltage to the set point level because of a very low DC loop resistance. In this event, switch the control mode to voltage control, turn the main set point to zero, then disconnect the +ve anode cable. **Very slowly** wind up the output volts to the desired trip level then adjust the VL trimpot anti-clockwise until the VL LED just energises. Restore the control mode as required.

**3. Set Auto Reference Control**

3.1 For AUTO control, the main set point calibrated dial is 10 turns for a 5 volt set point range which represent 0.5V per turn. Fully anti-c/w represents +1V structure to reference and fully clockwise represents -4V structure to reference. The following table shows the reference set point Vs number of turns. NOTE: These dial settings are nominal but they should be within +/- 0.1 volt

Str / Ref Set Point	Calibrated Dial Setting
<b>+1.0 V</b>	<b>0.00</b>
<b>+0.5V</b>	<b>1.00</b>
<b>0.0V</b>	<b>2.00</b>
<b>-0.5V</b>	<b>3.00</b>
<b>-1.0V</b>	<b>4.00</b>
<b>-1.1V</b>	<b>4.20</b>
<b>-1.2V</b>	<b>4.40</b>
<b>-1.25V</b>	<b>4.50</b>
<b>-1.3V</b>	<b>4.60</b>
<b>-1.4V</b>	<b>4.80</b>
<b>-1.5V</b>	<b>5.00</b>
<b>-2.0V</b>	<b>6.00</b>
<b>-2.5V</b>	<b>7.00</b>
<b>-3.0V</b>	<b>8.00</b>
<b>-3.5V</b>	<b>9.00</b>
<b>-4.0V</b>	<b>10.00</b>

3.2 Set up AUTO Reference control as follows:

- (i) Wind the set point down to zero amps and volts
- (ii) Switch to AUTO mode
- (iii) Slowly increase the set point while observing the current and reference potential. In circumstances described as in 1.3 (a), the desired reference potential will instantly establish. In circumstances described as in 1.3 (b), the potential set point can be adjusted using the chart above. It is normal in this case for the current to turn fully on and invoke the current limit. Adjust the voltage and current limits down to an acceptable value.
- (iv) As the structure potential approaches the set point, the current and voltage will automatically reduce and come out of the limited state.
- (v) Finally, re-adjust the set point based on "instant off" potentials and when the structure is finally polarised, fine tune the voltage and current limits

#### 4. Fuses

DC input (F1) and DC output fuse (F2) is located on the circuit board.  
Both fuses are type ATO Blade fuses

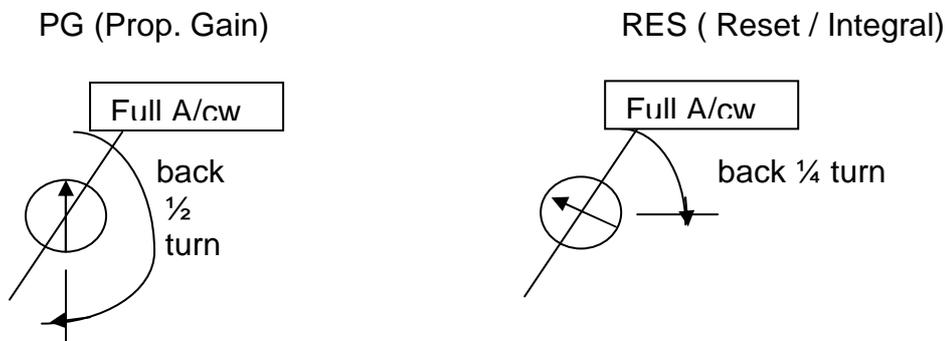
If in doubt, check with an ohm meter in situ. They should read <0.5ohm

#### 5. Proportional Gain and Integral

These two settings are designed to promote control loop stability which may be necessary depending on field conditions. Typical examples of the need to adjust these two trimpots are:

- DC output hunting due to interaction with other units in the same environment.
- DC output unstable due to very low field resistance, ie, low volts / high current.

The settings for the PG and RES which suits most applications is as follows:



The RES adjustment controls the speed of response to a step change of output. Fully anti-c/w is the fastest and most likely to be unstable

The PG adjustment controls the amount the output has to change before the control loop responds. Fully anti-c/w is the lowest gain and the most stable. Fully clockwise produces a very sensitive control response but it is likely to be very unstable.

Generally, we recommend the RES adjustment to be 1/4 turn back from fully anti-c/w and the PG to the fastest position that will produce a stable output.

CPUs at each end of an isolated section of pipe may hunt each other in AUTO potential mode which causes the output currents to be more variable than they should be. Whichever of the two CPUs is outputting the most current on average to maintain the potential, try turning the RES trimpot more clockwise until the hunting minimizes.

#### 6. Dual Current Ranges

The installed CPU may include dual current shunts with switchable negative outputs with the low range being 1/10<sup>th</sup> of the high range. The low range will permit Current control with x10 sensitivity and together with the external current meter, this will suit outputs from zero to tens of milli-amps. The low range output

is recommended for outputs up to say 5% of current range as the resolution of current control, Current limit setting and metering is improved by a factor of 10.

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