

### Application Notes

#### 1. Scope

These Application Notes are a guide to applying the G122-826-001 Mobile P-I Servoamplifier. A knowledge of application fundamentals is assumed. These notes provide details of each circuit feature to enable a user to optimise their amplifier configuration. They cover the following process:

- Determine the closed loop structure for your application.
- Select the G122-826-001 for your application. Refer also to data sheet G122-826.
- Determine your closed loop system configuration.
- Use these Application Notes to determine your amplifier configuration.
- Draw your wiring diagram.
- Install and commission your system.

Aspects such as hydraulic design, actuator selection, feedback transducer selection and performance estimation, are not covered by these Application Notes. The G122-202 Application Notes (part no C31015) cover some of these aspects. Moog Application Engineers can provide more detailed assistance, if required.

#### 2. Description

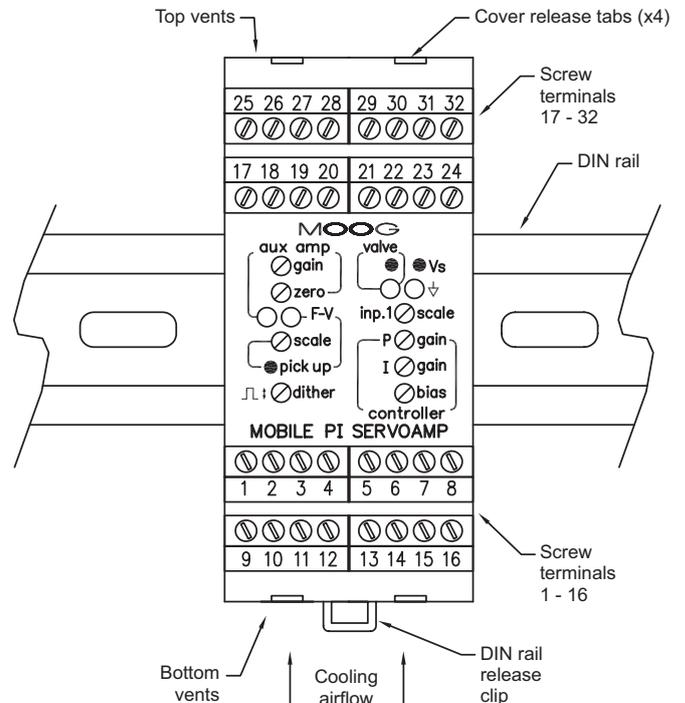
The G122-826-001 is a general purpose, user configurable P-I servoamplifier with a power supply input filter suitable for automotive use. It can also be used in industrial applications, where its unique features make it particularly useful. Selector switches inside the amplifier enable proportional control, integral control or both to be selected. Many aspects of the amplifier's characteristics can be adjusted with front panel trim pots or selected with internal switches. This enables one amplifier to be used in many different applications. Refer also to data sheet G122-826.

#### 3. Installation

##### 3.1 Placement

A horizontal DIN rail, mounted on the vertical rear surface of an industrial steel enclosure, is the intended method of mounting. The rail release clip of the G122-826-001 should face down, so the front panel and terminal identifications are readable and so the internal electronics receive a cooling airflow.

An important consideration for the placement of the module is electro magnetic interference (EMI) from other equipment in the enclosure. For instance, VF and AC servo drives can produce high levels of EMI. Always check the EMC compliance of other equipment before placing the G122-826-001 close by.

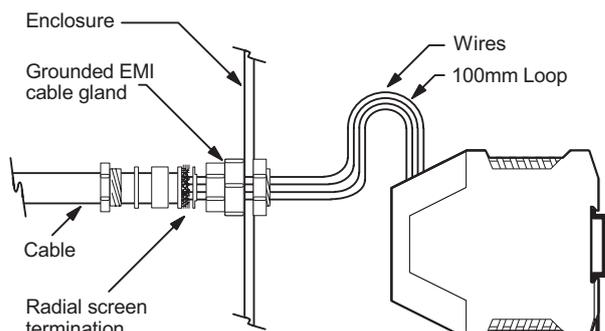


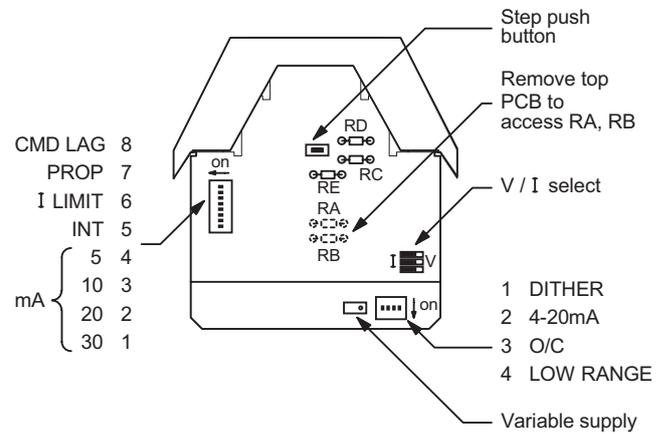
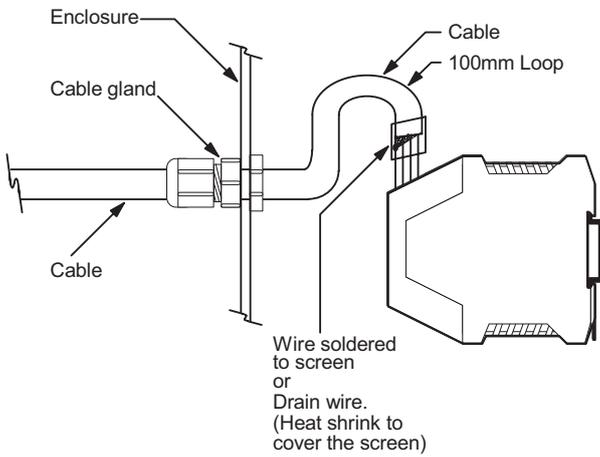
##### 3.2 Cooling

Vents in the top and bottom sides of the G122-826-001 case provide cooling for the electronics inside. These vents should be left clear. It is important to ensure that equipment below does not produce hot exhaust air that heats up the G122-826-001.

##### 3.3 Wiring

The use of crimp "boot lace ferrules" is recommended for the screw terminals. Allow sufficient cable length so the circuit card can be withdrawn from its case with the wires still connected. This enables switch changes on the circuit card to be made while the card is still connected and operating. An extra 100mm, for cables going outside the enclosure, as well as wires connecting to adjacent DIN rail units, is adequate.





### 3.4 EMC

The G122-826-001 emits radiation well below the level called for in its CE mark test. Therefore, no special precautions are required for suppression of emissions. However, immunity from external interfering radiation is dependent on careful wiring techniques. The accepted method is to use screened cables for all connections and to radially terminate the cable screens, in an appropriate grounded cable gland, at the point of entry into the industrial steel enclosure. If this is not possible, chassis ground screw terminals are provided on the G122-826-001. Exposed wires should be kept to a minimum length. Connect the screens at both ends of the cable to chassis ground.

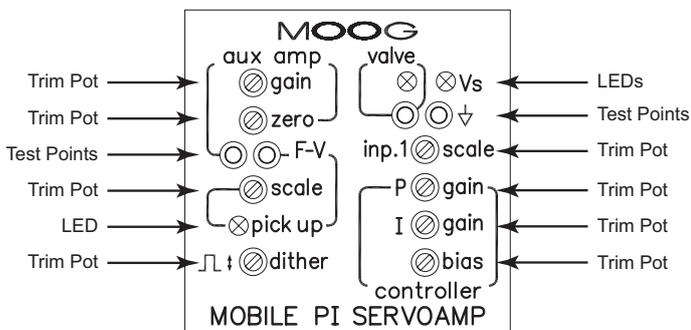
### 4. Power supply

9V to 32V DC operating range. An input filter provides protection against transient and level variations typically present in automotive battery supplies. During engine starting the output of the servoamplifier will be indeterminate. Therefore, **it is essential to isolate the load actuator during engine starting.**

V supply	I supply, mA, @ no load	I supply, mA, @ 50 mA load
13.8	90	173
27.6	52	93

It is recommended that the M205, 250mA T (slow blow) fuse, supplied with the unit, be placed in series with the +24V input to protect the electronic circuit. There is a spare fuse in the cover of the fuse holder. Replacement fuses should be compliant with IEC 127-2 sheet 3.

### 5. Structure



The servoamplifier consist of a number of functional blocks. Many of the blocks are configurable and there is some degree of flexibility in how the blocks are interconnected. The block-wiring diagram on page 5 shows each block and how they are interconnected.

Summary of the circuit structure:

- Three inputs to a unity gain error amp.
- Separate P and I stages follow error amp.
- P and I stage outputs switched to limit amp.
- Limit amp also sums dither and a fourth input.
- An optional non-linear block can be loaded to customer specification.
- An optional dual gain block, to suit a standard dual gain M062-802 valve, can be loaded.
- Output amplifier with switch selectable voltage and current.
- Switch selectable current ranges.
- Auxiliary amp with uncommitted output.
- Frequency to voltage converter with uncommitted output.
- Variable supply for transducer excitation.
- Dither oscillator.
- Power supply input filter suitable for automotive environment but can be equally applied to industrial systems.

### 6. Circuit description

Refer to the block-wiring diagram on page 5.

#### 6.1 Error amplifier

The error amp has a fixed gain of -1 and four inputs. They are inputs 1 to 3 and the **bias** trimpot.

- Input 1 has a **scale** trimpot that enables large inputs to be scaled down to match smaller signals on other inputs. Scale range is 10 to 100%. Set fully clockwise, (FCW) an input of 100V can match a 10V signal on the other inputs.

It has a switch selectable lag of 55mS that can be used to remove input signal transients that could cause unwanted rapid movement in the output.

Input 1 is well suited to be a command because of these two features. If input 1 is used for feedback, make sure the lag is switched off. Input resistance after the scale trimpot is 94k Ohms.

- Input 2 has a plug-in resistor RD, enabling gain changes. The 100k Ohms loaded for dispatch gives a nominal 0 to 10V input signal range. This input is suitable for command or feedback.

- Input 3 has a fixed 100k Ohm resistor for a nominal input range of 0 to 10V. There is the option of plug-in resistor RC to give a derivative (lead or D). This can be useful if input 3 is used as a feedback input.
- The **bias** trimpot produces  $\pm 15\%$  of full scale valve drive when the P gain is set to minimum.

### 6.2 Proportional amplifier

When dispatched, this amplifier has a gain adjustment range of 1 to 20, set by RE being 100k Ohms. Increasing RE will increase the gain. For example, 200k Ohms gives a range of 2 to 40. The circuit will function correctly with a value of RE between 100k Ohms and 10M Ohms.

### 6.3 Integrator

Like the proportional amplifier, the integrator receives its input from the error amplifier and has its output switched to the input of the limit amplifier with the INT switch. When the integrator is selected with the INT switch but the closed loop is inactive, it should be clamped with a contact closure between terminals 8 and 16. Gold contacts should be used. The I limit switch limits the output of the integrator to  $\pm 15\%$  of full scale. This can be useful in a position loop that may require integral control to achieve the required steady state accuracy. The limited integral control removes valve null error when the final position is reached.

### 6.4 Non-linear block

This circuit is not loaded on the G122-826-001. The intent is that it will be configured by the system Engineer and then loaded at the time of manufacture by Moog. To obtain a schematic and advice on configuring this circuit, contact Moog Australia at the address on the last page of this application note.

### 6.5 Limit amplifier

This amplifier sums the P signal, I signal, dither, non-linear block and input 4. It then limits its output to  $\pm 105\%$  of valve drive. Its output then drives the output amplifier.

### 6.6 Dual gain amplifier

This circuit is loaded, if requested, at the time of manufacture. It has the inverse characteristic of an M062-802 dual gain servovalve.

### 6.7 Output and sense amplifier

The output and sense amplifiers operate together to drive the load, provide an LED indication of the output drive and provide a test point normalised to  $\pm 10V$  for  $\pm 100\%$  valve drive.

When voltage (V) is selected,  $\pm 10V$  is available into a minimum load of 200 Ohms. When current (I) is selected, the current level switches enable  $\pm 5$  to  $\pm 50mA$  to be selected. The switch selections sum, so, if for instance 35mA is required, select 20, 10 and 5. The output can drive all known Moog valves up to  $\pm 50mA$ . The maximum load at I (Amp) output is:

$$RL \text{ max.} = \left( \frac{11V}{I \text{ (Amp)}} - 39 \right) \text{ Ohms}$$

e.g. At 50mA RL max. is 181 Ohms

The output amplifier is limited to approximately 105% of the selected full scale output. If both the proportional and integrator stages are saturated, the output will not be twice the selected full scale but only 105% of full scale.

### 6.8 Auxiliary amplifier

Features of the auxiliary amplifier are:

- Differential or single ended inputs.
- **Gain** and **zero** adjustment trimpots.
- Switch selectable 4-20mA input load.
- Output test point.
- Output not hard wired to any other point enables the user flexibility in connection.

### Default

The auxiliary amplifier default set-up is 4-20mA flowing into terminal 18 and out of terminal 17, producing an output of 0 to  $-10V$ .

### 6.9 F to V converter

The frequency to voltage converter accepts either a 5V TTL or an open collector input. The performance tables below are for a 50% mark space input waveform and a full scale (FS) output on terminal 27 of 8.0V.

Range	Scale CW	Scale CCW
LO	80 Hz	380 Hz
HI	330 Hz	1600 Hz

### Typical full scale (FS) ranges for 50% mark space ratio

If a 30-70% mark space ratio is used, the 380Hz figure drops to 230Hz and the 1600Hz figure drops to 1000Hz.

Turning the **scale** trimpot clockwise increases the output voltage for a given input frequency.

Range	Ripple, mVp-p	
	Scale CW	Scale CCW
LO, at FS	220	15
LO, at 10% FS	620	340
HI, at FS	20	5
HI, at 10% FS	90	25

### Typical output ripple voltage at FS and 10% FS

Range	Rise time, mS	
	Scale CW	Scale CCW
LO	65	20
HI	60	20

### Typical 63% rise times

The two FS frequency ranges have been chosen based on experience with previous mobile speed control applications. Output ripple and rise time are a compromise, again chosen based on previous experience. These three characteristics can be changed at the time of manufacture to suit a particular application. Consult a Moog Application Engineer, if this is required.

### 6.10 Variable supply

This supply could be used as a transducer excitation or a command signal to some other part of the equipment. The trimpot that sets its output, R13, is on the bottom right hand corner of the bottom circuit board. To access R13 remove the circuit card from its case. See section 7 for instructions.

## 6.11 Dither oscillator

The dither frequency is fixed at 200 Hz and the level is adjustable with the front panel trimpot to  $\pm 10\%$  of valve drive, regardless of the type and level of valve drive selected.

## 6.12 Step push button

The step push is used when commissioning a system. It injects  $-50\%$  valve drive into the output. When released the valve drive reverts to its original value.

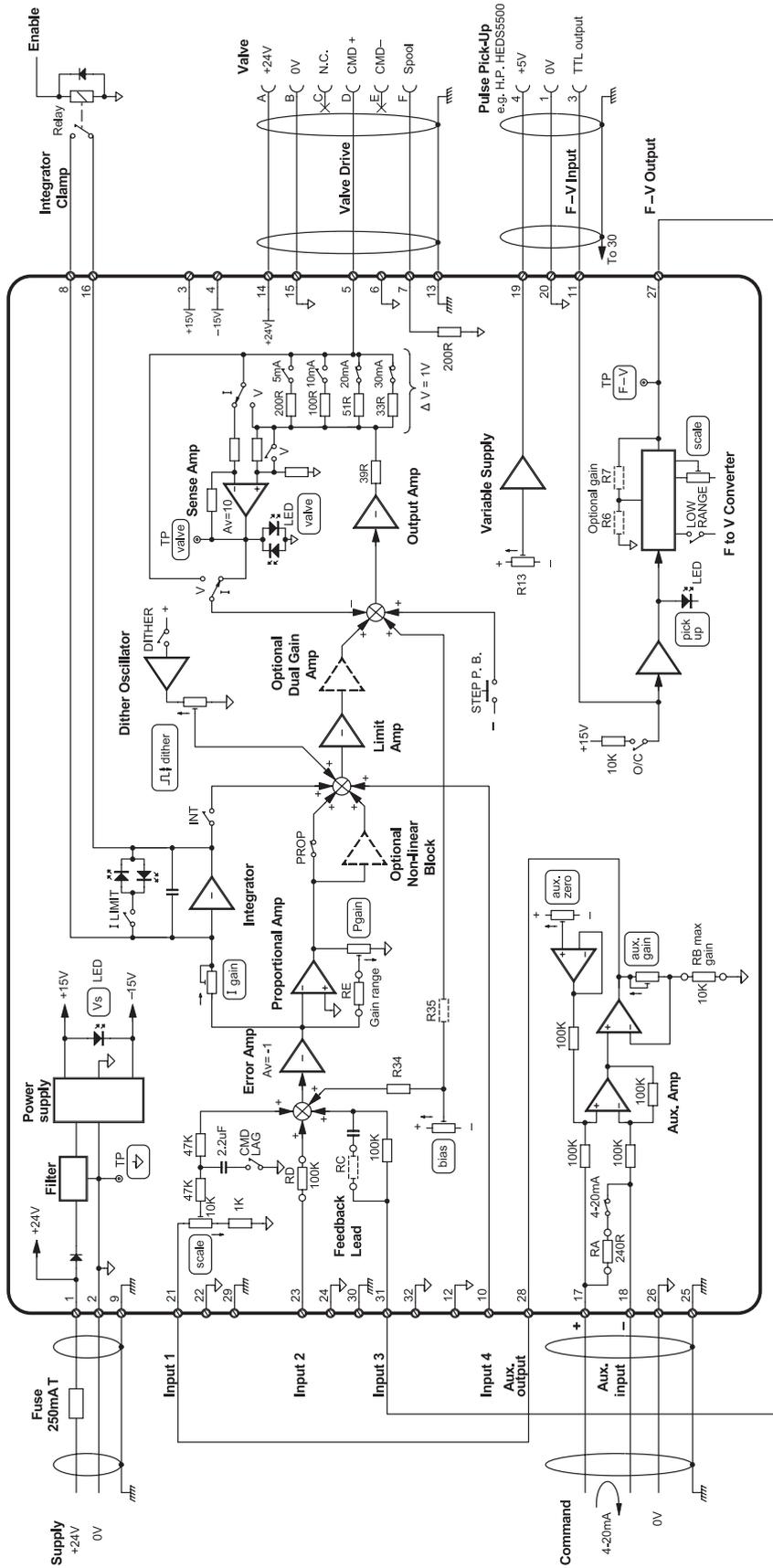
## 7. Withdrawing the circuit card from its case

The circuit card needs to be withdrawn from its case to change the plug-in resistors, set the selector switches, operate the step push button and set the variable supply. To do this, push one tab with a pen or screwdriver, while gently pulling on the top cover on that side. The cover will release approximately one mm. Repeat on the second tab on that side. Repeat on the other side and then withdraw the cover and circuit card until the required component is exposed. The rigidity of the connecting wires will hold the circuit card in position while changes are made.

## 8. Specifications

<b>Function:</b>	P, I or P & I, switch selectable	<b>Valve supply:</b>	Pin 14, 300mA max.
<b>Input 1:</b>	Scaled to 100V max. with switch selectable lag of 55ms	<b>Front panel indicators:</b>	Vs, internal supply – green Valve drive positive – red negative – green F-V pick up – yellow
<b>Input 2:</b>	Plug-in resistor, 100k Ohms nominal, $\pm 10V$	<b>Front panel test points:</b>	Valve – $\pm 10V$ (regardless of output signal selection) Auxiliary amplifier output F-V output Signal 0V
<b>Input 3:</b>	Fixed 100k Ohms, $\pm 10V$ Derivative (velocity) feedback via plug-in resistor and fixed capacitor	<b>Front panel trimpots:</b>	Input 1 scale Error amp bias P gain I gain Dither level Auxiliary amp gain Auxiliary amp zero F-V scale
<b>Input 4:</b>	Direct to output amp, $\pm 10V$ gives $\pm 100\%$ valve drive Rin – 10k Ohms	<b>Dither:</b>	200Hz fixed frequency 0 to $\pm 10\%$ valve drive Switch selectable on/off
<b>Auxiliary amp:</b>	Differential 4-20mA or $\pm 10V$ , switch selectable, $\pm 15V$ max. input Rin – 100k Ohms, $\pm 10V$ Rin – 240 Ohms, 4-20mA Zero – $\pm 10V$ Gain – 1 to 10	<b>Supply:</b>	9V to 32V DC 173mA @ 13.8V and 50mA valve drive
<b>F to V:</b>	TTL or open collector input, switch selectable Input threshold – 2.3V TTL input resistance – 10k Ohms OC pull up – 10k Ohms to +15V Full scale output – 8.0V Full scale ranges – 380 and 1600Hz	<b>Recommended supply protection:</b>	M205, 250mA T (slow blow) fuse compliant with IEC 127-2 sheet 3
<b>Variable supply:</b>	$\pm 12V$ @ $\pm 20mA$ max.	<b>Mounting:</b>	DIN rail IP 20
<b><math>\pm 15V</math> output:</b>	$\pm 10mA$ max.	<b>Temperature:</b>	0 to +40°C
<b>Error amp:</b>	Unity gain Bias – $\pm 15\%$ valve drive	<b>Dimensions:</b>	100W x 108H x 45D
<b>Proportional amp gain:</b>	1 to 20	<b>Weight:</b>	240gm
<b>Integrator gain:</b>	1 to 45 per second	<b>CE mark:</b>	EN61000-6-3 emission EN61000-6-2 immunity
<b>Output amp:</b>	Switch selectable voltage or current, single ended output, return to ground V. $\pm 10V$ , minimum load = 200 Ohms I. $\pm 5, 10, 20, 30mA$ to a maximum of $\pm 50mA$ Max. load = $\left(\frac{11V}{I(Amp)} - 39\right)$ Ohms	<b>C tick:</b>	EN61000-6-3 emission
<b>Step push button:</b>	$-50\%$ valve drive		

# 9. Block-wiring diagram



- Notes
1. = plug-in resistor
  2. = optional or not loaded components
  3. = front panel component
  4. switches shown in default shipping mode
  5. connect current spool signal to terminal 7

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## Internet Data

For a detailed Data Sheet and the latest version of these Application Notes, please refer to the Moog website [www.moog.com/dinmodules](http://www.moog.com/dinmodules)

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