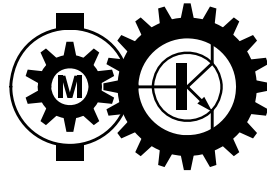


Mclennan Servo Supplies Ltd.

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MSE421 / PM421

Linear Servo Motor Amplifier User Handbook

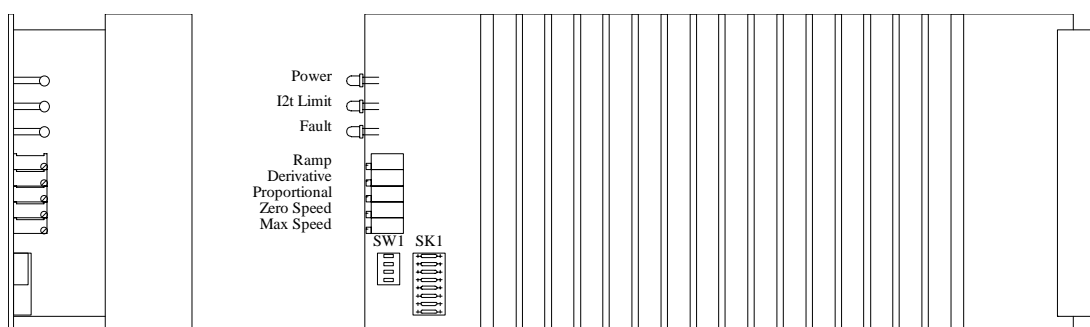
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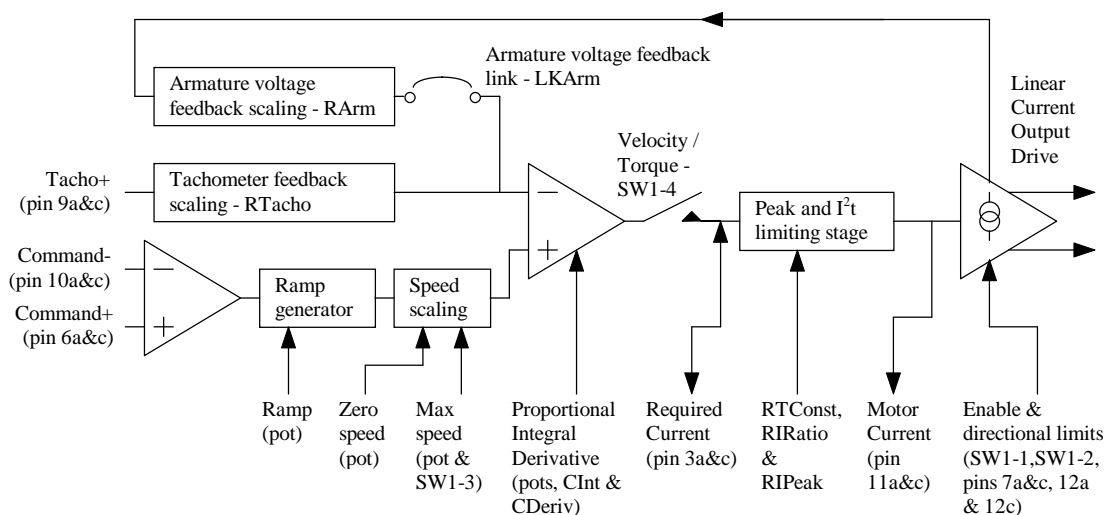
MSE421/PM421

The MSE421 EuroAmp is a linear amplifier. It features

- * Linear MOSFET output stage
- * Operates from a single supply rail
- * Adjustable current limiting
- * Torque or Velocity control
- * Tachometer or Armature voltage feedback
- * Adjustable velocity control parameters
- * Enable and directional limit inputs
- * Rack mounting extended eurocard format
- * MSE421 when fitted with front panel is referred to as PM421



Block Diagram



The amplifier has a linear output stage whose output current is proportional to the input voltage. It is also controlled by an enable input and directional limit inputs. The enable input may be used to enable or disable the output. The directional limit inputs may be used to prevent the output driving in a particular direction and therefore may be used as end of travel limits. The action of these inputs may be inverted by the switches SW1-1 and SW1-2 (see set up section).

The current limiting stage limits the input to the output stage. The peak current limit is set by resistor RIPeak on the personalisation header. The peak current limit is the maximum current output that the amplifier is allowed to produce. The ratio between the nominal current and the peak current limit (set as above) is set by the resistor RIRatio. The nominal current limit should be set less than or equal to continuous current rating of the motor i.e. the rated stall current.

In use, if a current greater than the nominal is demanded, then this will be available (bounded by the peak current limit) for a time set by the time constant. The current drawn above the nominal limit is squared and accumulated over time, and when this exceeds the time constant set by the resistor RTConst, the output current will be reduced down to the nominal level. This will therefore allow short bursts of peak current for acceleration, but restricts the heating of the motor over longer periods of use.

This output level is available on the Motor Current output for monitoring.

If the amplifier is to be used as a torque control, the required current is input on the Required Current input with SW1-4 off. The sensitivity is approximately 0.42A/V.

If velocity control is required, then SW1-4 should be closed and the Required Current pin may be used as a monitoring output.

The velocity feedback may be derived from either a motor fitted tachogenerator or the voltage across the motors armature.

For tachogenerator feedback, fit a resistor RTacho as described in the setting up section. Do not fit link LKArm.

For armature voltage feedback, fit link LKArm and a resistor RArm as described in the setting up section. Do not fit resistor RTacho.

The required velocity command signal should be applied to the differential command inputs. This is then fed through a ramp generator, controlled by the RAMP pot. With this pot fully clockwise, there will be no ramping. Turning the pot anti-clockwise will increase the ramp time and therefore reduce the maximum rate of change of the required speed.

The speed signal is then scaled by the MAX SPEED pot. Turning this pot clockwise will reduce the speed demanded for a given input signal. Turning anti-clockwise will increase the speed. If you cannot get enough speed with the pot fully anti-clockwise, then the gain can be increased by closing switch SW1-3.

The ZERO SPEED pot may be used to set the output speed to zero when no input is applied.

The PROPORTIONAL and DERIVATIVE pots are used to set the velocity loop response. Turning the PROPORTIONAL pot anti-clockwise will increase the loop gain and turning the DERIVATIVE pot anti-clockwise will increase the derivative action.

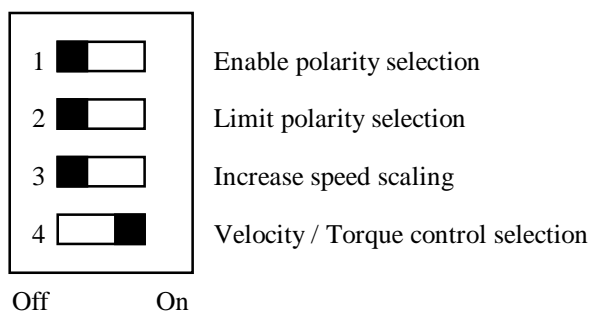
If the derivative response is insufficient, then it can be increased by fitting a capacitor in the CDeriv position of the personalisation header. Likewise, the integration function may be increased with CInt.

The pots are all thirty turns from end to end.

**ENSURE THAT THE AMPLIFIER IS MOUNTED TO
ALLOW SUFFICIENT AIRFLOW AROUND THE
HEATSINK, WITH THE HEATSINK VANES
VERTICAL**

MSE421 Set-up

The MSE421 amplifier may be set up by DIP switch SW1, the personalisation header SK1 and the edge mounted pots.



Switch 1 Enable Polarity Selection.



Drive DISABLED on applying +10 to +30V to the enable input



Drive ENABLED on applying +10 to +30V to the enable input

Switch 2 Limit Polarity Selection.



Directional limit activated on applying +10 to +30V to a limit input



Directional limit deactivated on applying +10 to +30V to a limit input

Switch 3 Increase Speed Scaling.



Normal speed scaling



Enhanced speed scaling (positional mode)

Switch 4 Velocity / Torque Control Selection.



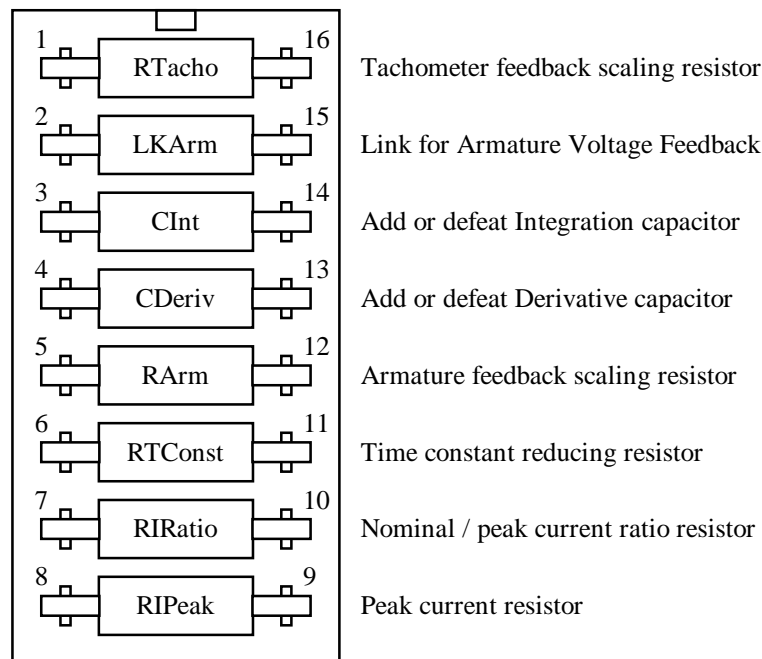
Torque control (using Required Current as input)



Velocity control

The above example (default) shows the amplifier using velocity control with normal speed scaling, not requiring enable or limit signals.

The personalisation header is a removable device, into which resistors and capacitors may be soldered to set up parameters of the drive. If a drive is being replaced then this header may be removed and transplanted into the new drive.



RTacho is a resistor for scaling the tachometer feedback. Do not fit if not using tachometer feedback. The value of RTacho may be calculated by the following formula:

$$RTacho = (400 * V_m * K_e) - 2000 \Omega$$

where V_m is the maximum speed in thousands of RPM. (rpm/1000)
 K_e is the voltage constant of the tachometer in volts per thousand rpm (V/1000rpm)

LKArm is a link or 0Ω resistor that must be fitted to use armature voltage feedback. Do not fit RTacho if using this feedback mode.

CInt is an extra capacitor that may be fitted to increase the integration function. A link may also be fitted to defeat the integration function (for use with positional controllers such as the PM304).

CDeriv is an extra capacitor that may be fitted to increase the derivative function.

RArm is a resistor for scaling the armature feedback. The link LKArm must be fitted for this to have an effect. The value of RArm may be calculated by the following formula:

$$RArm = 260 * V_m * K_e \Omega$$

where V_m is the maximum speed in thousands of RPM. (rpm/1000)
 K_e is the voltage constant of the motor in volts per thousand rpm (V/1000rpm)

RTConst is a resistor that may be fitted to reduce the current limit time constant. Fitting a 220KΩ resistor will halve the time constant.

RIRatio is a resistor to set the ratio between the nominal current limit to the peak current limit. The nominal current limit is therefore also dependent on the peak current limit set by RIpeak. Care must be taken not to exceed the thermal limitations of the motor or amplifier.

The value of RIRatio may be calculated by the following formula:

$$RIRatio = 15000 / [(Inom/Ipeak)^2 - 0.125] \Omega$$

where Inom is the required nominal current limit. (A)

Ipeak is the peak current limit set by RIpeak. (A)

∴ (Inom/Ipeak) is the ratio between the nominal and peak current limits.

Inom/Ipeak ratio:	1/3 (35%)	1/2 (50%)	2/3 (66%)	3/4 (75%)
RIRatio:	not fitted	120K	47K	33K

RIpeak is a resistor to set the peak current limit. The nominal current limit is a ratio of the peak current limit and therefore is also affected by RIpeak. Care must be taken not to exceed the thermal limitations of the motor or amplifier.

The value of RIpeak may be calculated by the following formula:

$$RIpeak = (4700 * Ipeak) / (4.2 - Ipeak) \Omega$$

where Ipeak is the required peak current limit. (A)

Ipeak:	4A	3A	2A	1A	0.5A
RIpeak:	100K	12K	4K3	1K5	680Ω

The default components for the MSE421-60 or PM421-60 version are:

RIpeak = 100KΩ - Peak current limit = 4A

RIRatio = 120KΩ - Ratio = 1/2 ∴ nominal current limit = 2A

Rtacho = 680Ω

Example 1

A M78CT12V for velocity control using tachometer feedback with the following characteristics:

Peak Current = 3A

$$RI_{\text{Peak}} = (4700 * 3) / (4.2 - 3) = 11750\Omega$$

∴ use 12K Ω

Nominal Current = 1A

$$\therefore \text{Nominal to peak current ratio} = 1A / 3A = 1/3$$

$$RIRatio = 15000 / [(1/3)^2 - 0.125] = -1080000 \Omega$$

∴ do not fit RIRatio

Maximum speed = 2000 rpm ∴ $V_m = 2 \text{ rpm}/1000$

Tacho voltage constant = 3.25 V/1000rpm ∴ $K_e = 3.25 \text{ V}/1000\text{rpm}$

$$RTacho = (400 * 2 * 3.25) - 2000 = 600\Omega$$

∴ use 680 Ω

Enable and directional limits are not being used and are not connected so set SW1-1 and SW1-2 to OFF.

Enhanced speed scaling should not be required so set SW1-3 to OFF.

Velocity control so set SW1-4 to ON.

Example 2

A M540 motor for velocity control using armature voltage feedback with the following characteristics:

Peak Current = 14.8A

$$RI_{\text{Peak}} = (4700 * 14.8) / (4.2 - 14.8) = -6562\Omega$$

∴ do not fit RI_{Peak} **Peak current limit = 4.2A**

Nominal Current = 2.8A (To avoid overheating, do not use 100% duty cycle at this current).

$$\therefore \text{Nominal to peak current ratio} = 2.8A / 4.2A$$

$$RIRatio = 15000 / [(2.8/4.2)^2 - 0.125] = 46956 \Omega$$

∴ use 47K Ω

Armature voltage feedback so fit link for LKArm

Maximum speed = 3000 rpm ∴ $V_m = 3 \text{ rpm}/1000$

Motor voltage constant = 7.4 V/1000rpm ∴ $K_e = 7.4 \text{ V}/1000\text{rpm}$

$$R_{\text{Arm}} = 260 * 3 * 7.4 = 5772\Omega$$

∴ use 5K6 Ω

Enable input is not being used and is not connected so set SW1-1 to OFF.

Directional end of travel limits are connected via normally closed switches to +24V so set SW1-2 to ON.

Enhanced speed scaling should not be required so set SW1-3 to OFF.

Velocity control so set SW1-4 to ON.

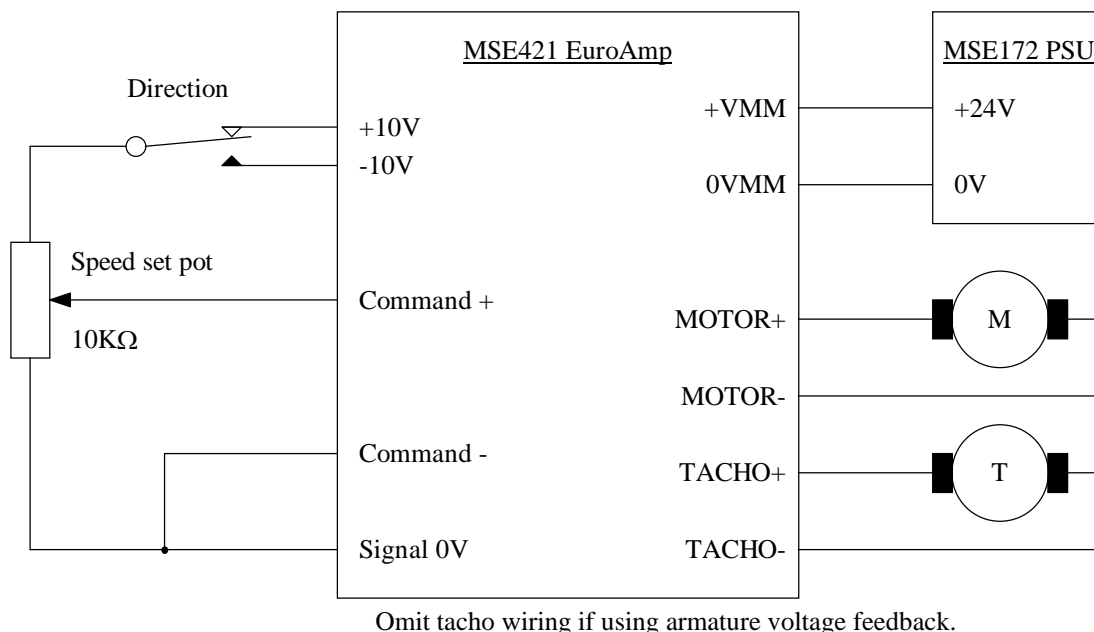
External Connections

Connector	Name	Type	Description
01a & c	Signal 0V		For low current reference. DO NOT USE FOR POWER SUPPLY.
02a & c	Protections Active	Output	This open collector output is pulled low to 0V when the drive is healthy. It may rise high when either the I ² t current limiting is active or the fault protection is active. Maximum current is 10mA.
03a & c	Required current	Input Output	In torque control mode (SW1-4 off), this input is used to demand the amount of output current required, with a sensitivity of approximately 0.42 amps per volt. In velocity control mode (SW1-4 on), this connection may be used to monitor the amount of current demanded by the velocity control circuit. No signal should be applied to this connection in this mode.
04a & c	-10V reference	Output	This -10V reference output may be used to power a potentiometer for example. Maximum current is 3mA.
05a & c	+10V reference	Output	This +10V reference output may be used to power a potentiometer for example. Maximum current is 3mA.
06a & c	Command +	Input	Velocity command non inverting input. The required velocity signal should be applied between this and the Command - differential inputs.
07a & c	Enable	Input	If SW1-1 is ON then the drive will be ENABLED on applying +10 to +30V to this input. If SW1-1 is OFF then the drive will be DISABLED on applying +10 to +30V to this input.
08a & c	Tacho -	Input	The tachometer feedback signal should be applied between this and the Tacho + input. This is internally connected to 0V.
09a & c	Tacho +	Input	The tachometer feedback signal should be applied between this and the Tacho - input.
10a & c	Command -	Input	Velocity command inverting input. The required velocity signal should be applied between this and the Command + differential inputs.

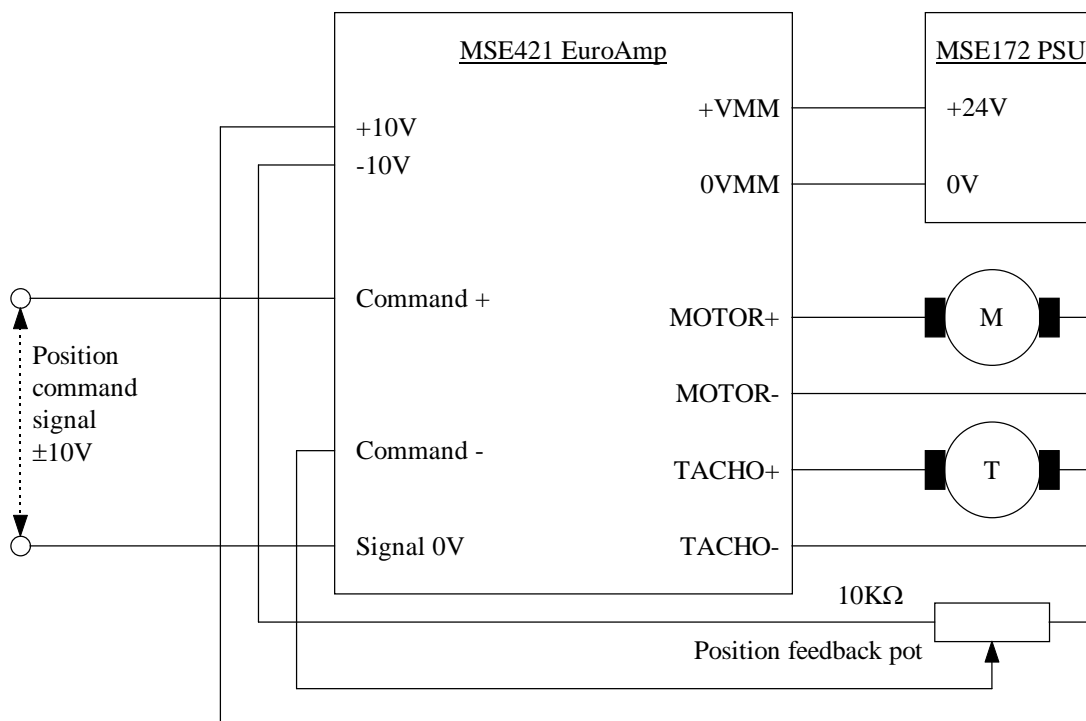
11a & c	Motor current	Output	This connection may be used to monitor the amount of current demanded of the drive after the current limit circuits. The output is approximately 2.4V/A
12a	Limit +	Input	If SW1-2 is OFF then a positive output will normally be allowed and will be suppressed on applying +10 to +30V to this input. If SW1-2 is ON then a positive output will normally be suppressed and will be allowed on applying +10 to +30V to this input.
12c	Limit -	Input	If SW1-2 is OFF then a negative output will normally be allowed and will be suppressed on applying +10 to +30V to this input. If SW1-2 is ON then a negative output will normally be suppressed and will be allowed on applying +10 to +30V to this input.
14 - 17 a & c	+VMM	Power	Positive power supply to amplifier; +10V to +30 V DC (Absolute maximum supply voltage: +32Vdc).
19 - 22 a & c	0VMM	Power	Power supply 0V.
24 - 27a & c	Motor +	Output	Motor Output
29 - 32a & c	Motor -	Output	Motor Output

We recommend the use of the MSB 520 motherboard. This unit enables easy installation of the drive into a 3U rack as a plug-in unit. Connections are then made by screw terminals.

An example of a speed controller using a potentiometer and tachometer velocity feedback.



An example of a positional servo using a potentiometer as a position feedback and tachometer velocity feedback.



MSB520 Data Sheet

The MSB520 is the motherboard, designed to facilitate connections to either a MSE421 / PM421 or a Mini Maestro (DCD60) servo motor amplifier.

This board is 3U high and 7E wide, and is to be fitted in the backplane area of a 3U rack. It has a 64 way DIN41612 connector for connection to an amplifier allowing it to be a plug in unit. On the other side there are plug-in screw terminals for all control connections and high current screw terminals for the power and motor connections.

Control connections

Terminal	Ident	Description	Amplifier pin
1	I Motor	Motor Current monitor output	11 a&c
2	Prtn Act	Protections Active output	2 a&c
3	I reqd	Required Current (TPRC) input or output	3 a&c
4	Sig 0V	Signal 0V	1 a&c
5	-10V ref	-10V reference voltage output	4 a&c
6	+10V ref	+10V reference voltage output	5 a&c
7	Enable	Enable input	7 a&c
8	Commd+	Command (required speed) signal non inverting input	6 a&c
9	Sig 0V	Signal 0V	1 a&c
10	Commd-	Command (required speed) signal inverting input	10 a&c
11	Tacho-	Tacho feedback inverting input (0V)	8 a&c
12	Tacho+	Tacho feedback non inverting input	9 a&c
18	Limit-	Negative limit input (MSE421/PM421 only)	12 c
19	Limit+	Positive limit input (MSE421/PM421 only)	12 a

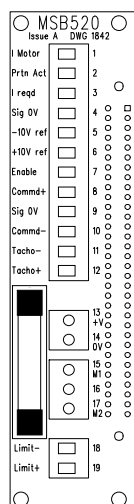
Power supply connections

Terminal	Ident	Description	Amplifier pin
13	+V	Power supply + (+VMM or +DC)	14-17 a&c
14	0V	Power supply 0V (0VMM or -DC)	19-22 a&c

Motor connections

Terminal	Ident	Description	Amplifier pin
15	M1	Motor Output (Motor+)	24-27 a&c
16		not connected	
17	M2	Motor Output (Motor-)	29-32 a&c

There is a fuseholder to accept 1¼” fuses, between terminal 13 (+V supply) and the amplifier. A 5 amp quick blow HRC fuse should be used.



Connection side view of MSB520.