VIO SERIES

Installation and Operating Manual

Rev 05/99

VIO - SAFETY INSTRUCTIONS

Read this page carefully before installation and use of the instrument, and follow all instructions in section 4 of Installation Procedures for safe installation of this product.

INTRODUCTION

The following clauses contain information, cautions and warnings that must be followed to ensure safe operation and to retain the instrument in a safe condition.

This product is intended for incorporation into a machine or end product. The end product must comply with all safety aspects of the relevant requirements of the European Safety of Machinery Directive 89/392/EEC as amended, and with those of the most recent versions of standards EN60204-1 and EN292-2 at least.

Only qualified personnel shall carry out installation, adjustment, maintenance and repair of the instrument.

WARNINGS

Any removal from the structure or removal of parts, except those to which access is permitted, is likely to expose live parts and accessible terminals, which can be dangerous to life. Any adjustment, maintenance or repair, of the opened instrument under voltage, shall be performed **only** by a qualified person who is aware of the hazard involved.

The instrument shall be disconnected from all voltage sources before it is opened (for service method).

Any interruption of the protective earth conductors inside the instrument is likely to make the instrument dangerous.

Components, which are important for the safety of the instrument, may only be renewed by components obtained through Elmo service organization.

Before switching on, ensure that the instrument has been installed in accordance with the Installation Instructions.

Maximum DC supply must be according to the types described in the operating manual.

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1. Introduction

This manual is intended for the use of the design engineer who is implementing the VIO servo amplifier into his machine. It covers the various aspects of the implementation process from basic understanding of the product concept and features, through a detailed explanation of the user accessible functions, down to mounting guide lines and requirements from peripheral devices.

Chapter 2, "Servo Amplifier Description", includes a description of the various features of the VIO, a list of all the pins and their functions and a block diagram of the product.

Chapter 3, "Operation of the Servo Control", describes all the user accessible functions and gives the design engineer the guide line as for how to design the peripheral circuits.

Chapter 4, "Mounting and Wiring Instructions", covers the requirements from peripheral equipment like motors, cables, the power supply in order to achieve successful operation of the VIO.

Chapter 5, "Status Indications" summarizes all the indication outputs that are available to the user in order to determine the amplifier status.

2. Servo Amplifier Description

This new series of miniature servo amplifiers for DC brush motors incorporates custom mixed analog/digital ICs and hybridized power stage. The basic configuration is a current mode amplifier targeting the OEM market. No trimmers are used in the basic version.

The product meets UL508c and the suitable CE regulations.

The power stage is implemented on a single ceramic substrate. This design enables very high thermal conductivity, high current carrying capacity, better EMC and good mechanical strength. The control section is implemented by dedicated custom ICs that contribute to higher and improved performance.

2.1. Standard features

- Operation in current mode
- Internal DC to DC converter allows for operation from a single supply
- Zero dead band
- Excellent linearity
- 1 differential input
- Motor current monitor
- Current gain change for low inductance motors
- Current feedback multiplier for low current motors
- Status indication and remote control functions by three open collector transistors
- External continuous and peak current limits adjustments
- Latch mode for the protective features
- Interface via soldering pins
- Package: plated copper base plate, plastic housing, UL94V0 recognized

2.2. Fault protection

- Short between the outputs or between each output and the Power Return.
- Over temperature
- Under/over voltage

2.3. Type designation

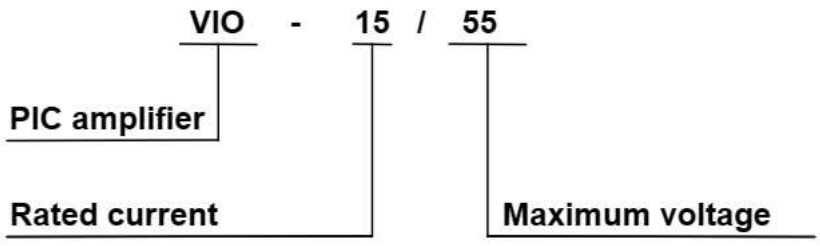


Figure A: Type Designation

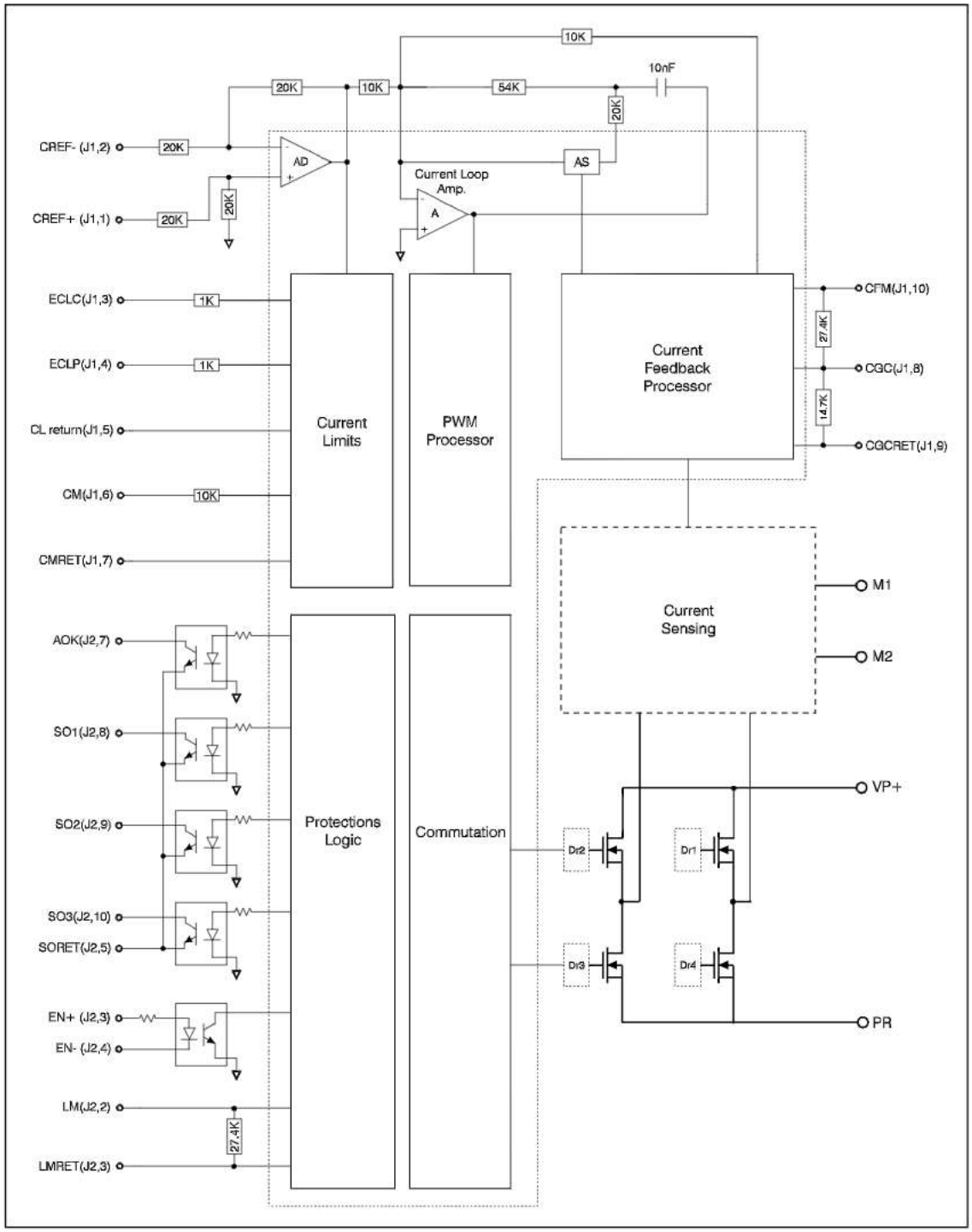


Figure B: Block diagram of the VIO

2.4. Pins Functions

Figure C: Connectors location

2.4.1. Power connections

Table A: Power connections

Pin	Function	Remarks
VP+	Positive power Input	
PR	Power input Return	
M_1	Motor power output 1	
M_2	Motor power output 2	This output will be positive when pin J1/1 is positive relatively to pin J1/2

2.4.2. Control connections

Table B: connector J1

Pin # / Short form	Function	Remarks
1 CREF+	Current command Input (+)	Positive input of a differential amplifier. • Input operating voltage range: ±3.75V • Max. input voltage: ±20V • Max common mode voltage: ±6V (referred to CMRET) • Differential input impedance: 40 Kohm
2 CREF-	Current command Input (-)	Negative input of a differential amplifier. Specification as for pin J1/1.
3 ECLC	External current limit - continuous	External voltage scales down the rated value. • Voltage range: 0V to 3.75V (3.75V = rated Ic). • Internally limited to the rated value.
4 ECLP	External current limit – peak	External voltage scales down the rated value. • Voltage range: 0V to 3.75V (3.75V = rated Ip). • Internally limited to the rated value.
5 ECLRET	Current limits return	Return for the current limits signals.
6 CM	Current monitor	Analog output with a scale of ±3.9V for ±Ip. • Output resistance: 10Kohm
7 CMRET	Current monitor return	Return for the current monitor (CM) signal.
8 CGC	Current gain change	Shorting this pin to the CGCRET pin (J1/9) reduces the proportional gain (P) of the current loop by 70%.
9 CGCRET	Current gain change return	Return for CGC signal
10 CFM	Current feedback multiplier	Shorting this pin to pin J1/8 (CGC) multiplies the current feedback signal by 2.

Table C: connector J2

Pin # / Short form	Function	Remarks
1 LMRET	Latch mode return	Return for Latch mode (LM)
2 LM	Latch mode	Latch Mode input
3 EN+	Enable (+)	Positive voltage input of the "Amplifier Enable" function. To enable the operation of the amplifier the opto must be "on". This is done by applying voltage between this pin (+) and pin J2/4 (-). Opto isolated from the amplifier. See Figure B. • Minimum "ON" voltage: 3V , current consumption 0.6 mA. • Maximum "ON" voltage: 15V , current consumption 5.4 mA.
4 EN-	Enable (-)	Negative voltage input of the "Amplifier Enable" function. Opto isolated from the amplifier. For details see pin J2/3.
5 SORET	Status output return	Status Outputs Common for AOK, SO1, SO2, SO3. Isolated from the circuit common. For details see Figure B.
6 SORET	Status output return	Status Outputs Common for AOK, SO1, SO2, SO3. Isolated from the circuit common. For details see Figure B.
7 AOK	Amplifier OK	"Amplifier OK" indication output pin. When the amplifier is at normal operating conditions this output is in "active Low " state. When a failure occurs this output is changed to "open" state. Opto isolated, open collector NPN type. see Fig B. • Max. voltage = 30V • Max. Current = 8 mA. • "On" voltage: $V_{OUT(On)} < 0.8V$
8 SO1	Status output 1	Status indication output 1. Specification as in pin J2/7.
9 SO2	Status output 2	Status indication output 2. Specification as in pin J2/7.
10 SO3	Status output 3	Status indication output 3. Specification as in pin J2/7.

3. Operation of the servo control

3.1. Current command Input

The VIO has 1 differential input. The input operating voltage range is ±3.75V. This means that a 3.75V signal will result in a full rated peak current. The currents limits circuits will override this signal if the peak duration is beyond 2.7 seconds and/or the required current exceeds the values set by the ECLC and ECLP signals.

Care must be taken not to apply input voltage above the maximum input voltage as this will cause the input op amp to operate beyond its limits (±20V) and in extreme cases may even damage the op amp.

3.2. CFM

The amplifier is equipped with Current Feedback Multiplier (CFM). By connecting pin J1/10 to J1/8 the signal of the current feedback is multiplied by 2 and consequently the following changes occur:

- Current gains are divided by 2.
- Current monitor is multiplied by 2.
- Current limits are divided by 2.

This function should be activated whenever the rated current AND the peak current of the motor are less than 50% of the amplifier rated continuous and peak limits respectively.

	Cont. Current limit	Peak Current limit	Current Gain(A/V)	Current monitor (V/A)	Differential Input impedance
With no CFM	Ic	Ip	Ip/3.75	3.9/Ip	40Kohm
With CFM	Ic/2	Ip/2	Ip/7.5	7.8/Ip	40Kohm

Table D: CFM effects

The default (pin J1/10 left open) is low current feedback .

For permanent selection a simple short is recommended.

For remote selection the scheme of Figure D should be used.

3.3. Current Gain Control (CGC)

The amplifier is equipped with Current Gain Control (CGC) for improved performance of low induction motors. By connecting pin J1/8 to J1/9 the gain of the current loop is reduced, thus enabling the use of low inductance motors without the insertion of an additional inductor. The default (pin J1/8 left open) is high gain.

Shorting this pin to the circuit common pin (J1/9) reduces the proportional gain (P) of the current loop by approx. 70%.

For permanent selection a simple short is recommended. For remote selection, the scheme of figure D should be used.

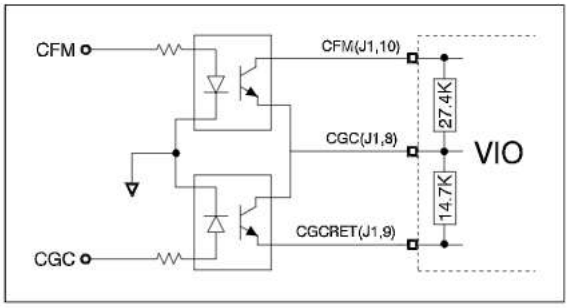


Figure C: CFM & CGC remote control..

In the following table, minimum and maximum inductance values can be calculated.

	Minimum inductance for High Gain	Minimum inductance for Low Gain
25/50	$L_{Load\ (millihenry)} > 2.4*10^{-3} * V_{supply\ (Volt)}$	$L_{Load\ (millihenry)} > 0.9*10^{-3} * V_{supply\ (Volt)}$
15/55	$L_{Load\ (millihenry)} > 4*10^{-3} * V_{supply\ (Volt)}$	$L_{Load\ (millihenry)} > 1.6*10^{-3} * V_{supply\ (Volt)}$
10/100	$L_{Load\ (millihenry)} > 9*10^{-3} * V_{supply\ (Volt)}$	$L_{Load\ (millihenry)} > 2.2*10^{-3} * V_{supply\ (Volt)}$
15/100	$L_{Load\ (millihenry)} > 6*10^{-3} * V_{supply\ (Volt)}$	$L_{Load\ (millihenry)} > 1.5*10^{-3} * V_{supply\ (Volt)}$
6/200	$L_{Load\ (millihenry)} > 16.5*10^{-3} * V_{supply(Volt)}$	$L_{Load\ (millihenry)} > 4*10^{-3} * V_{supply\ (Volt)}$

Table E: Minimum inductance values

3.4. External Current Limit - Continuous (ECLC)

The amplifiers' continuous current limit can be scaled down by an external voltage or by an external resistor connected between pin J1/3 (ECLC) to pin J1/5 ((ECLRET).

External voltage:

An external positive voltage (0 to 3.75V) to terminal J1/3 (ECLC) in reference to terminal J1/5 (ECLRET) will control continuous current limit from zero to Ic(nom).

$$Ic(new) = \frac{V_{ECLC}}{3.75V} * Ic(nom)$$

Remarks:

- The voltage will be internally clamped to 3.75V whenever the external V_{ECLC} will be higher than 3.75V.
- The external voltage source must be capable to source/ sink at least ±0.2 mA.
- The max absolute V_{ECLC} is 12V.

External Resistor:

Connect an external resistor between terminal J1/3 (ECLC) and terminal J1/5 (ECLRET). The resistor value is given by:

$$R_{ECLC}\ (Kohm) = 37.4 * \frac{Ic(new)}{Ic(nom)} - 1$$

Remarks:

- $0 < R_{ECLC} < 36.4K$ (1/8 Watt)
- At R_{ECLC} larger than 36.4K the current limit will be internally clamped to the nominal value.
- $I_{C(nom)}$ is the nominal continuous current limit of the amplifier.

3.5. External Current Limit - Peak (ECLP)

The amplifiers' peak current limit can be scaled down by an external voltage or by an external resistor connected between pin J1/4 (ECLP) and pin J1/5 (ECLRET).

External voltage:

An external positive voltage (0 to 3.75V) to terminal J1/4 (ECLP) in reference to terminal J1/5 (ECLRET) will control peak current limit from zero to Ip(nom).

$$Ip(new) = \frac{V_{ECLP}}{3.75V} * Ip(nom)$$

Remarks:

- The voltage will be internally clamped to 3.75V whenever the external V_{ECLP} will be higher than 3.75V.
- The external voltage source must be capable to source/ sink at least ±0.2 mA.
- The max absolute V_{ECLP} is 12V.

External Resistor:

Connect an external resistor between terminal J1/4 (ECLP) and terminal J1/5 (ECLRET). The resistor value is given by:

$$R_{ECLP}\ (Kohm) = 37.4 * \frac{Ip(new)}{Ip(nom)} - 1$$

Remarks:

- $0 < R_{ECLP} < 36.4K$ (1/8 Watt)
- At R_{ECLP} larger than 36.4K the current limit will be internally clamped to the nominal value.
- $I_{P(nom)}$ is the nominal peak current limit of the amplifier.

3.6. Latch mode (LM)

By connecting J2/2 to J2/1, whenever one of the following failures: Short, Commutation failure and Over Temperature occur the amplifier will be latched in Disable mode.

Disabling the amplifier (removing the power from the Enable pins (J2/3 and J2/4) resets the latch.

For permanent selection a simple short is recommended. For remote selection the scheme of figure D should be used.

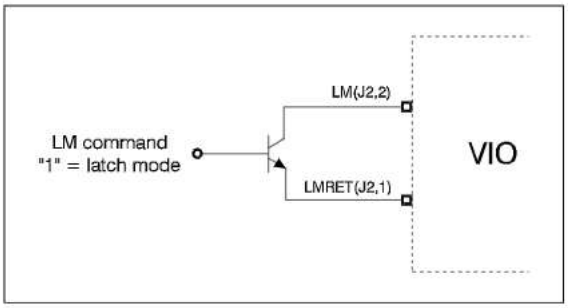


Figure D: LM remote control

3.7. Amplifier Enable logic

Pins J2/3 and J2/4 are the inputs of an opto-coupler. The opto-coupler must be energized to enable the operation of the amplifier.

If the Enable input is kept High before powering the amplifier, the amplifier power output will be active immediately upon power on.

4. Mounting and wiring instructions

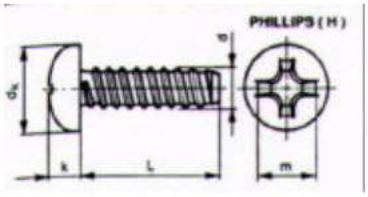
4.1. Heat Sink Mounting

The FLU series dissipates its heat by natural convection up to loads of 500W. For higher output load the amplifier should be mounted on an additional heat sink or cooled by fan. There are two 4.5mm holes in the base plate for mounting to an additional heat sink (see **Error! Reference source not found.**).

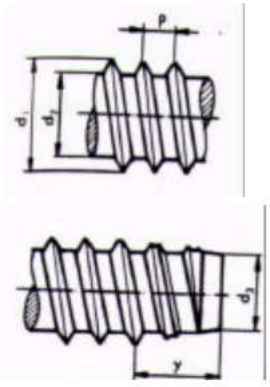
4.2. PC board Mounting

When mounting the FLU to PC boards four screws may be installed to provide a mechanical connection, other than the solder pins. It is important to provide a spacer if any components are located above the amplifier. Failure to do so can warp the PC board or puncture the amplifier case. When selecting screws the following specifications should be used. If a spacer has been added the screw length must be calculated to penetrate the case by no more than 2.6 mm.

Screw Type: Phillips Pan Head Self-tapping (for plastic) screw – Nickel-plated Steel. Meeting the standards of ISO 1478, EN 21478, or DIN 7970.



d	ST2.2
L	4.5*
P	0.8
d_k	4.2
k	1.8
m ≈	2.6
Phillips size	1



Dimension in mm

Limits of sizes for tapping screw thread

Basic Diameter	ISO Nr.	Pitch P	Major diameter		Minor diameter		Flat end diameter	
			D_{1max}	D_{1min}	D_{2max}	D_{2min}	D_{3max}	D_{3min}
ST2.2	2	0.8	2.24	2.1	1.63	1.52	1.47	1.37

Dimension in mm

*4.5mm length is typical for mounting to a PC board assembly without spacers

4.3. Wiring

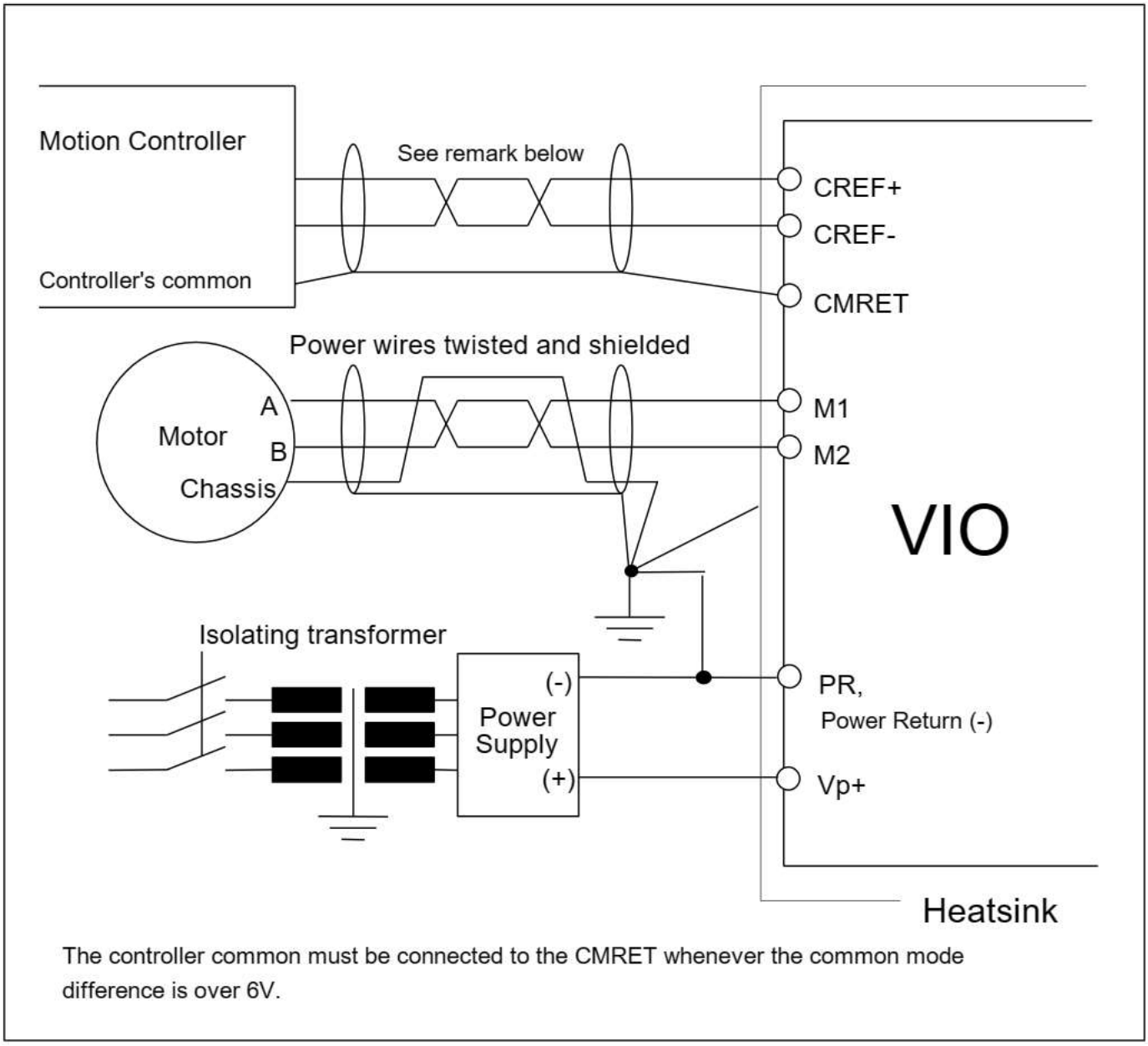


Figure E: Motor wiring

Guide lines for connecting a non isolated amplifier with an isolating power transformer

Ground:

DC power common

Motor chassis

Amplifier's heat sink

Do not ground:

Control common - It is internally connected to the power common. Grounding the control common will create a ground loop.

4.4. DC power supply

DC power supply can be at any voltage in the range defined within the technical specifications. The supply source must comply with the safety aspects of the relevant requirements in accordance with the most recent version of the standard EN60950 or equivalent Low Voltage Directive Standard, all according to the applicable over voltage Category. If the power source to the power supply is the AC line (through a transformer), safety margins have to be considered to avoid activating the under/over voltage protection due to line variations and/or voltage drop under load.

In addition to the above, the transformer must comply with the safety aspects of the relevant requirements in accordance with the most recent version of the standard EN60742 (Isolating and Safety Isolating Transformers). The nominal DC bus voltage should be in the following range:

$$1.2V_{dcmin} < Vdc < 0.9V_{dcmax}$$

V_{dcmin} - Minimum DC bus

V_{dcmax} - Maximum DC bus

Recommended minimum power supply capacitance for single phase connection:

Type of amplifier	VIO-25/50	VIO-15/55	VIO-10/100	VIO-6/200
Recommended capacitance	5600∝F	5600∝F	3300∝F	1500∝F

The transformer power should be calculated to have the capability to deliver power to the amplifier (including peak power), without significant voltage drops.

The power supply should be located as close as possible to the amplifier. Maximum distance is 30cm (1 foot).

While driving high inertia loads, the power supply must be equipped with a shunt regulator, otherwise, the amplifier will be disabled whenever the capacitors are charged above the maximum voltage.

5. Status indications

Table F: Status indication

	Function	Latch option	AOK	SO1	SO2	SO3
1	Amplifier OK (AOK)	N/A	Low	Open collector	Open collector	Open collector
2	External disable	No	Low	Low	Open collector	Low
3	Current limit	No	Low	Open collector	Open collector	Low
4	Short	Yes	Open collector	Low	Open collector	Low
5	Over temperature	Yes	Open collector	Open collector	Low	Low
6	Internal supplies protection	No	Open collector	Low	Low	Open collector
7	Under voltage	No	Open collector	Low	Open collector	Open collector
8	Over voltage	No	Open collector	Open collector	Low	Open collector
9	Shunt	No	Low	Open collector	Low	Open collector
10	Power Up Reset	No	Open collector	Open collector	Open collector	Open collector

Notes:

1. **Without Latch mode**: The status indications are reset when the fault disappears.
2. **With Latch mode**: The status indications (temperate and short) are reset when the enable signal is removed from the enable input.
3. **Multiple faults**: Only the reading of the first fault is reliable. Additional faults add on to the status outputs and the indication will be meaningless.

6. Technical specifications

Table G: Rating specification

Type	DC Supply Min-Max(V)*	Current limits Cont/Peak(A)
VIO-25/50	10-49	25/50
VIO-15/55	10-56	15/30
VIO-10/100	20-96	10/20
VIO-15/100	20-96	15/30
VIO-6/200	40-196	6/12

Table H: Electrical specification

Parameter	Value
DC output voltage	>93% of DC input voltage
Switching frequency on the load	32kHz (±5%)
Current loop response	3kHz minimum
Current step response	<150∝s
Efficiency at rated current	97%
Peak current duration (full rated peak current)	2.7seconds ±15%
Continuous current limit tolerance	-1% +5%
Peak current limit tolerance	-1% +5%
Current gain linearity	Better than ±1% of rated continuous current
Current gain accuracy	Better than ±5% for 0.05Ic<Imotor>Ip
Current monitor accuracy	Better than ±5% for 0.05Ic<Imotor>Ip

* These are the absolute minimum-maximum DC supply voltages under any condition.

Table I: Environmental specification

Parameter	Value
Operating ambient temperature	0-60 ℃
Max. case temperature	87 ℃ (-2 ℃/+7 ℃)
Storage temperature	-40 - +100 ℃
Operating humidity	90% non condensing
Max. operating altitude	30,000 feet
Storage humidity	98% non condensing
Protective coating	Applied to all the circuits

Table J: Mechanical specification

Parameter	Value
Size	82x47x25.4 mm
Weight	0.25 Kg
Power pins material	Brass with tin plating
Power pins size	1.14mm (.045") square
Power pins PCB layout	1.8 ±0.05mm (0.071 ±0.002")
Signal pins (J1, J2) material	phosphor bronze with 10µ gold plating
Signal pins (J1, J2) size	0.5 ±0.1mm (.02 ±0.004") square
Signal pins (J1, J2) PCB layout	1 ±0.05mm (0.04 ±0.002")

7. Appendix A: Drawings

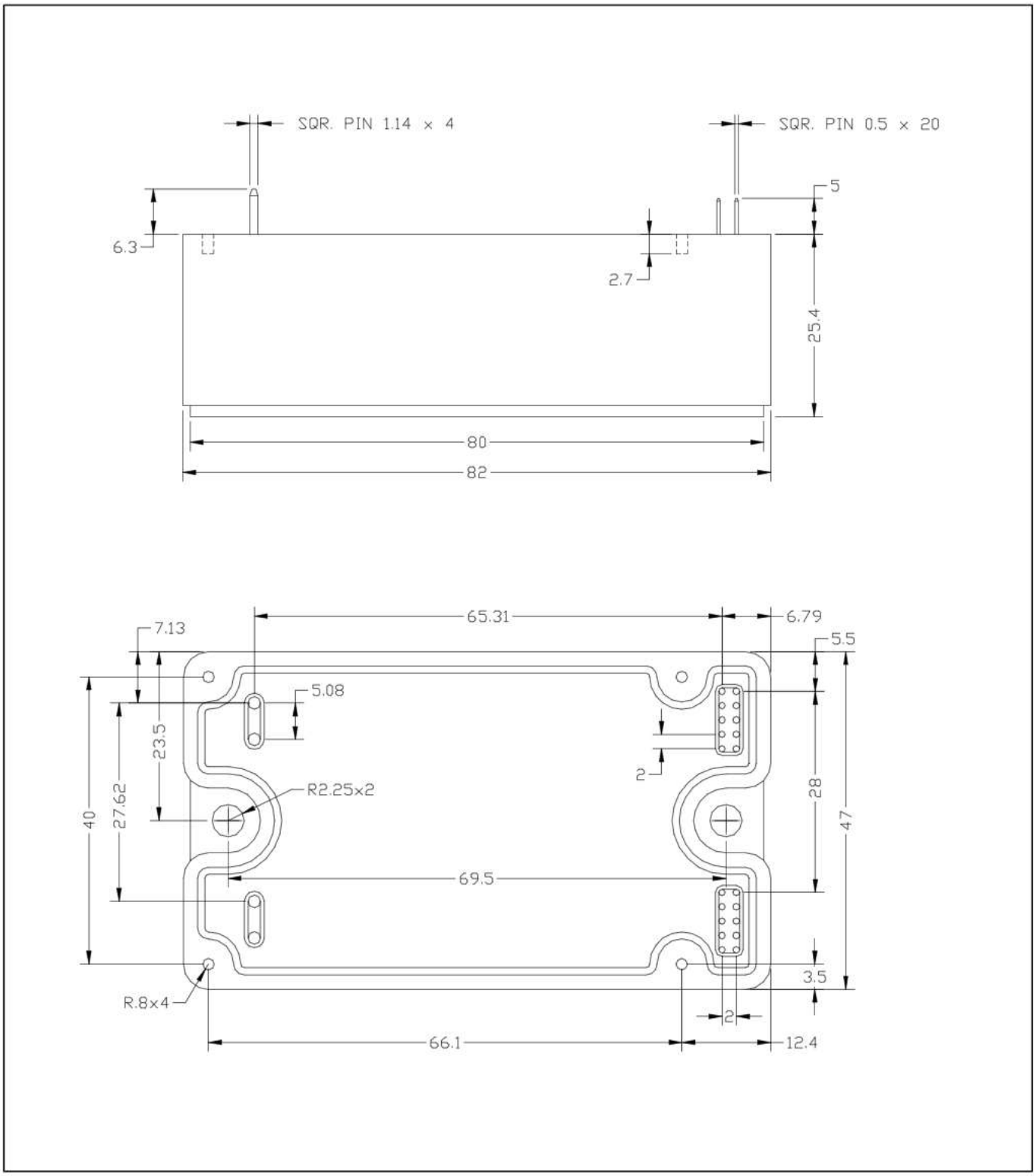


Figure F: Dimensional drawing (in mm)

Appendix B: Service Centers and Warranty

ISRAEL

Elmo Motion Control LTD

64 Gisin ST.

Petah-Tikva 49103

Tel: (03)922-0864

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7.1. Warranty performance

The warranty performance covers only ELMO's products and only the elimination of problems that are due to manufacturing defects resulting in impaired function, deficient workmanship or defective material. Specifically excluded from warranty is the elimination of problems that are caused by abuse, damage, neglect, overloading, wrong operation, unauthorized manipulations etc.

The following maximum warranty period applies:

12 months from the time of operational startup but not later than 18 months from shipment by the manufacturing plant.

Damage claims, including consequential damages, which exceed the warranty obligation will be rejected in all cases.

If any term or condition in this warranty performance shall be at variance or inconsistent with any provision or condition (whether special or general) contained or referred to in the Terms and Conditions of Sales set out at the back of Elmo's Standard Acknowledge Form, than the later shall prevail and be effective.