

1. DESCRIPTION

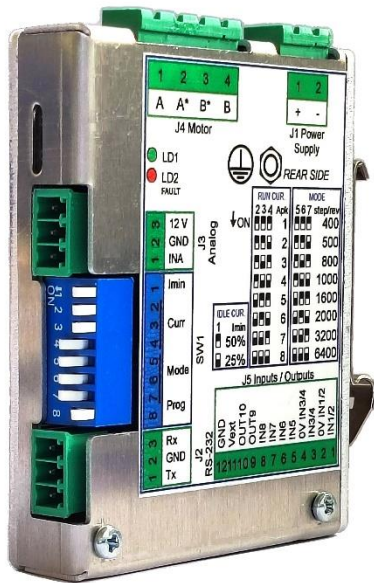


Fig. 1 – FD5.2

FD5.1, FD5.2 belongs to full-digital microstep family drives, DC-powered.

They are controlled by a 72 MHz ARM microcontroller, and equipped with very low R_{DS-ON} MOSFETs and Hall effect current sensors, for maximum efficiency, resulting in extremely small dimensions considering the performance: 8 A_P, 80 V_{DC}.

FD5.1 is the hardware code of fieldbus models: RS-485 Modbus RTU on FD5.1, CANopen on FD5.1A. They are equipped with 6 digital inputs (2 of them differential) and 2 digital outputs.

FD5.2 is not equipped with fieldbus; it provides the same I/O's and RS-232 as the FD5.1 model. It is intended to be operated in step/dir or with cycles and sequences programmed in flash from RS-232 and selectable from logical inputs. In this version an analogue input is also available to be connected to an external potentiometer.

The microcontroller is also powered by the 24 V_{EXT} so that, in the event of a power failure (emergency), communication remains active and the RAM data remains valid.

The user – through DwLoader PC software – can reprogram the configuration of the I/O according to his needs. Two differential inputs, normally used for step/dir, can also be used to count an incremental encoder for position verification.

All versions are equipped with a DIN rail hook.

Model	Power supply	Digital I/O	RS-232	RS-485	CANopen	Analog input
FD5.1	24 – 80 V _{DC}	✓	✓	✓		
FD5.1A		✓	✓		✓	
FD5.2		✓	✓			✓

Tab. 1 – hardware codes

2. ELECTRICAL CHARACTERISTICS

Property	Nominal values
Supply voltage range	From 24 V _{DC} to 80 V _{DC} (V _{MAX} 90 V _{DC})
Maximum supply current	6 A ¹ <i>Note: minimum power supply output capacity 450 µF</i>
Motor current	From 1 A _P to 8 A _P <i>FD5.1: programmable and editable via fieldbus or RS-232. FD5.2: can be set by dip switch (see table) or by RS-232</i>
Mode of operation	Microstep: from 400 to 204'800 step/rev (resolution = 50 x Num / Den) <i>FD5.1: Num e Den programmable (default: 12'800 step/rev. FD5.2: settable via DIP switch from 400 to 6'400 step/rev (see table), or via RS-232</i>
Motor type	Two-phase 4, 6, 8 wires. Inductance: 0.5 mH < L < 15 mH
Dimensions [mm]	80h x 18l x 64d (excluding DIN rail hook)
Operating temperature	from 0 °C to 45 °C ambient (microcontroller temperature alarm: 90 C°)
Protection rating	IP 20

Tab. 2 – Electrical characteristics

¹ Power supply current depend on supply voltage, motor current, speed and motor load. 7 A rapid fuse is mounted inside the drive.

3. PROTECTIONS

All models are equipped with short-circuit protection between the motor wires and between the wires and ground. Protection against overvoltage is also provided. This protection short-circuits the motor if, for example during braking, the voltage exceeds 85 V_{DC}. To avoid this alarm during deceleration, an electrolytic capacitor is required in parallel to the power supply, capable enough to accumulate the inertial mechanical energy of the load and the motor.

For "normal" loads, i.e., with not too much inertia and the presence of friction, 470 µF are sufficient.

In some cases, especially if low resolution are used, at certain frequencies, the motor can resonate, i.e., it transmits energy towards the power supply. Without the capacitor the overvoltage alarm could be triggered.

Generally, power supplies are already equipped with output capacitor, otherwise it must be added.

4. RISK AND PRECAUTION

- a. Stepper drives FD5 are basic drive modules, BDM (EN 61800-3). This means they are components to be integrated in higher complexity industrial equipment by qualified personnel, expert in the field of motor drive and in their related problems. Direct use of this product by final user is not allowed, only a professional assembler can install and put in service this component. They are addressed to limited distribution. Not qualified personnel use is forbidden. It is exclusive responsibility of the designer of the complete machine or installation, in which this component is used to take care of the safety and reliability of his project.
- b. FD5 are IP coded IP20. This means it must be installed inside protective cabinets in compliance with the standards of the specific application.
- c. Use for safety related functions is forbidden. It is also forbidden any application arrangement in which a drive fault or failure could generate a hazardous condition. For example, the "disable" input cannot be used in functions that concern safety.
- d. The use is prohibited in presence of gas or any other flammable material
- e. Hot surface: wait 10 minutes after switching off, before touching the equipment
- f. Risk of electric shock: wait at least 1 minute before working on the drive, to allow the capacitors to discharge
- g. Connections of connectors and set-up of current through dip-switches must be carried out strictly with the equipment turned off.
- h. The drive cannot be connected directly to the mains. It has to be supplied by a power supply equipped with transformer mains insulation.
- i. Drive could generate electromagnetic interference if instruction about installation directions is not respected. The compliance with 2014/30/UE directive has to be tested on whole machine in normal working condition and in accordance with specific standards covering the application.
- j. The drive cannot be dismantled, altered or repaired by un-authorized personnel.
- k. Inputs, outputs and serial lines are not galvanically insulated from power supply. Those terminals are not impedance protected. Thereby, in case of drive failure and power supply with dangerous voltages, such voltages could appear on logic output connections and serial lines. For this reason measures for the evaluation of machine safety during a single fault condition, the external control system, connected to these terminals, has to be considered potentially subject to high voltage, unless an external separation is provided.

5. ELECTRO-MAGNETIC COMPATIBILITY (EMC)

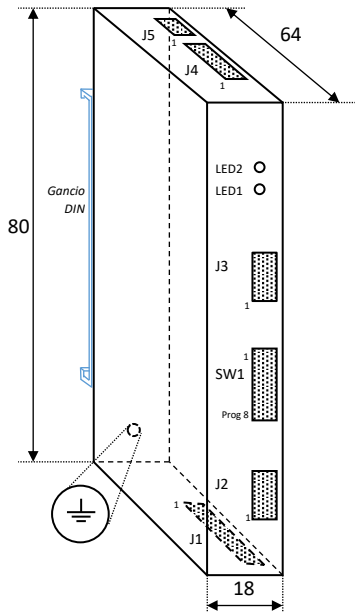
The drive, the connections and the motor are electromagnetic interference source (EMI) conducted and radiated.

In order to comply with EC Electromagnetic Compatibility Directive 2014/30/CE and the relevant standard EN 61800-3, it is necessary to abide by installation scheme and following indications:

- The drive shall be installed inside of a cabinet with shielded walls.
- The cable between the drive and the motor shall be shielded. Cable shield needs to be earthed on both sides with shortest path possible.
- Connection made to Protective Earth terminal (PE) must be short and have the lowest possible inductance.
- Interpose a filter near the AC main supply entrance, on transformer primary side.
- Use a double insulated transformer - with a metal shield between primary and secondary winding - and connect the shield to PE.
- Use varistors on transformer primary side and use TVS on the rectified DC voltage to protect the drives from over-voltages.
- FD5 drives are BDM integrated with the motor, conceived for restricted distribution. This means that Auxind has the responsibility to verify the product compatibility in the typical way of use in order to give correct installation directions. In any case, it is responsibility of the professional assembler, who installs this product, to verify the compatibility of the EMC of the complete system.
- Theoretically the drive could work without any earth connection in a complete floating system, but, in this case, some possible internal insulation failures will not be detected by protection system, causing potentially hazardous situation like dangerous voltage present on drive or I/O, moreover there could be much more problems in satisfying EMI requirements. The recommended solution is the connection of GND (the V- of rectified voltage) terminal to PE.
- Connect GND terminals to earth and to enclosure metal chassis with a line having a low high-frequencies impedance.
- Take care to ensure a good earth connection among different parts of chassis where the motor is installed.
- When cable length exceeds 5 meters use buffer type driving signals instead of open collector type.
- Verify logic compatibility when interfacing drive with control system.

These instructions do not exempt the user to test the whole machine.

6. INTERFACES



1	IN1/2	Step	1 – 24 V _{PP}
2		/Step	1 – 24 V _{PP}
3	IN3/4	Dir	1 – 24 V _{PP}
4		/Dir	1 – 24 V _{PP}
5	IN5	Dis. curr.	6 – 24 V
6	IN6	Dis. Freq.	6 – 24 V
7	IN7		6 – 24 V
8	IN8		6 – 24 V
9	OUT9	Drive ok	0 – V _{EXT}
10	OUT10	Running	0 – V _{EXT}
11	V _{EXT}		5 – 35 V _{DC} (24 V _{DC} typ.)
12	GND		

J1
I/O

Default factory configuration of I/Os in FD5.2.
Through DwLoader I/Os configuration can be edited. Ref. to firmware manual.

1	A
2	A*
3	B
4	B*

J4
Motor output

1	TxD232
2	GND
3	RxD232

J2
RS-232

1	24 - 80V _{DC}
2	GND

J5
Power input

Note: GND internally connected to earth

1	CAN L
2	GND
3	CAN H

J3
CAN

1	RS485 -
2	GND
3	RS485 +

J3
Modbus RTU

1	IN Analog
2	GND
3	12 V (2 kΩ out)

J3
Analog input

Note: FD5.1A

Note: FD5.1

Note: FD5.2
12 V external potentiometer
power supply
R_{POT} = 10 KΩ

7. INPUTS/OUTPUTS ELECTRICAL CHARACTERISTICS

Inputs 1/2 (Step) and 3/4 (Dir) are differential and designed for frequencies up to 300 KHz. Since these inputs are very fast, precautions such as shielded cable are needed to avoid disturbances. They can receive 5 V differential signals, or 6 - 24V single-ended signals.

In the second case, pins 2 and 4 must not be connected and the 0V of the signals. They must be connected to GND (J1/12).

When inputs are not configured as step/dir or encoder feedback, software filters are provided. The remaining four inputs 5, 6, 7, 8 are single-ended, PNP, 24 V_{DC}, digitally filtered. Their 0 V is GND (J1/12). The two outputs, PNP type, are powered by V_{EXT}. Generally, V_{EXT} = 24 V_{DC} (typical working voltage of PLCs), but if for example 12 V_{DC} outputs are needed, it is sufficient to power them at V_{EXT} = 12 V_{DC}.

Differential inputs 1/2 and 3/4 characteristics	Symbol	Rating
Maximum input voltage	V _{MAX}	30 V (40 V peak)
Maximum input current	I _{IN}	0.6 mA at 5 V, 3.5 mA at 24 V
Low level maximum input voltage	V _{IL-MAX}	4 V (single ended mode)
High level minimum input voltage	V _{IH-MIN}	6 V (single ended mode)
Low level maximum input current	I _{L-MAX}	0.5 mA (single ended mode)
High level minimum input current	I _{H-MIN}	1.5 mA (single ended mode)
Maximum step frequency (Step)	F _{MAX}	300 Kstep/sec (differential mode 5 V _{PP})
Minimum differential voltage (Step and Dir)	V _{MIN}	± 1 V _{PP} (differential mode)
Maximum differential voltage	V _{MAX}	± 24 V _{PP} (differential mode)
Maximum common mode voltage	V _{CM}	± 24 V _{PP} (differential mode)
Minimum duration of the frequency pulse (Step)	T _{MIN}	1 μs
		<i>Note: configurable rising or falling edge of step signal</i>
Maximum input voltage	T _{DIR-SETUP}	200 μs
		<i>Note: change of direction signal shall take place at least 200 μs before the first step edge</i>

Tab. 3 – Inputs 1/2 e 3/4 characteristics

Inputs 5, 6, 7, 8 and outputs 9, 10 characteristics	Symbol	Rating
Maximum input voltage	V _{MAX}	30 V (40 V peak)
Maximum input current	I _{MAX}	3 mA at 30 V
Low level maximum input voltage	V _{IL-MAX}	5 V
High level minimum input voltage	V _{IH-MIN}	8 V
Low level maximum input current	I _{L-MAX}	0,3 mA
High level minimum input current	I _{H-MIN}	1 mA
Maximum outputs power supply	V _{EXT-MAX}	30 V (40 V peak)
Maximum output current	I _{OUT-MAX}	1 A
		<i>Note: Outputs are short-circuit protected. Ref. to VND5160J datasheet.</i>
Outputs MOSFET resistance	R _{DS-ON}	160 mΩ
Maximum commutation energy		33 mJ
		<i>Note: Ref. to VND5160J datasheet.</i>

Tab. 4 – Inputs 5, 6, 7, 8 and outputs 9, 10 characteristics

8. MOTOR CURRENT SETTINGS

On FD5.1 models minimum and maximum currents are programmable on flash from DwLoader, or configurable from fieldbus. In this version, DIP switch SW1 selects node address. 7 switches are used for address, switch 8 is used to put the microcontroller in boot mode at power on (user flash program).

FD5.2 version is equipped with a factory setting where switches 2,3,4 of SW1 are configured as the current setting. User can however bypass this setting and configure the motor current from DwLoader (RS-232).

It is advisable to set "maximum motor current" to the minimum value needed for the application, maintaining sufficient torque margins and taking care not to exceed the maximum rated motor current. Too high currents heat the drive and motor unnecessarily, and they can introduce resonances.

In order to reduce unwanted heat (energy saving), motor current is automatically reduced when the motor is stopped at the programmable "minimum motor current" value. In FD5.2 version the "minimum motor current" can be set equal to 50 % or 25 % of the "maximum motor current" by acting on switch 1.

1	Reduction current
off	$I_{MIN} = 50 \% I_{MAX}$
on	$I_{MIN} = 25 \% I_{MAX}$

Tab. 5 – Automatic current reduction

2	3	4	Current [A] FD5.2
off	off	off	1
off	off	on	2
off	on	off	3
off	on	on	4
on	off	off	5
on	off	on	6
on	on	off	7
on	on	on	8

Tab. 6 – Maximum motor current

Note:

The heat generated by the drive is transmitted to environment by natural convection. The amount of heat depends on current setting, duty cycle and supply voltage. If high currents are set and if the temperature inside the cabinet (ambient) is high, it is recommended to check the steady state temperature of the aluminum case, in operating conditions. It must not exceed 80°C. If the temperature exceeds this limit, increment of the heat exchange surface or ventilation are needed. To protect the drive, overtemperature alarm - which brings to motor current disable - is provided which disables current.

9. POSITION RESOLUTION – STEP PER REVOLUTION (MODE)

On FD5.1 models the resolution, i.e. steps per motor revolution, can be programmed on flash by DwLoader, as a rational number, i.e. a ratio between two integers, in this way it is possible to choose a number that is not necessarily an integer. Ref. to firmware description.

On FD5.2 model, factory-installed firmware configures SW1 for the resolution settings (bits 5, 6, 7) (ref. to note in the box of this paragraph). One of the eight available values listed in the table can be chosen. The user can however program the resolution from DwLoader (RS-232) up to 204'800 steps/rev.

Higher resolutions benefits of a smoother motor motion, as the angle that corresponds to one step is smaller, smaller jumps between each step. However, the problem of low frequency resonances, typical of stepper motors, remains, although reduced.

Nelle versioni FD5.1 la risoluzione, cioè il numero di passi su giro motore è programmabile su flash da DwLoader, come rapporto fra due numeri interi, in tal modo si può scegliere un numero non necessariamente intero (razionale). Vedi descrizione firmware.

5	6	7	step/rev FD5.2
off	off	off	400
off	off	on	500
off	on	off	800
off	on	on	1'000
on	off	off	1'600
on	off	on	2'000
on	on	off	3'200
on	on	on	6'400

Tab. 7 - Mode (motore da 1,8 °)

Using switches 5, 6 and 7 of SW1 the resolutions listed in the table are used and inputs 1/2 and 3/4 are configured as step and dir respectively.

On FD5.1, but also on FD5.2, the resolution can be programmed from DwLoader and inputs 1/2 and 3/4 can be configured as step/dir or as quadrature signals, i.e., suitable to receive signals from an incremental encoder. The drive evaluates all edges (x4), so if for example an encoder with 400 pulses per revolution is used and step/rev = 1600, one encoder revolution corresponds to one motor revolution.

Even with FD5.2, if the needed resolution is not present in the table, it is possible to properly reprogram the correct parameters via DwLoader.

10. NODE ADDRESS SETTING

On FD5.1 models, i.e., models equipped with Modbus RTU or CANopen, SW1 has the function of node address setting (switches 1, 2, 3, 4, 5, 6, 7). Ref. to firmware description.

11. FLASH PROGRAMMING

Both FD5.1 and FD5.2 can be reprogrammed from PC using DwLoader. As described in detail in the firmware manual, the microcontroller firmware and parameters can be reprogrammed via RS-232 with a specific procedure: switch off power, turn switch 8 ON, then it powers on in programming mode (the green LED is off). Click "user flash program" (bolt symbol).

At the end of programming, turn off drive, put bit 8 off and turn on again. Green LED flashes.

Alternatively, from RS-232, RS-485 or CANopen, the drive can be programmed from fieldbus using "in application programming" (IAP) without the need to act on power supply and switch 8.

If only few parameters need to be modified, it is advisable to upload the parameters, modify the desired parameters, then select "parameters" and click IAP.

12. DIAGNOSTIC

FD5 is equipped with two LEDs on the front view: red and green

Meaning	LED's	Registers
Drive ok	Red LED off Green LED blinking: 5 Hz communication ON 0.5 Hz communication OFF	
In Application Programming	Red LED end green LED blinking alternatively 5 Hz communication ON 0.5 Hz communication OFF	ERR_FAT = 0 Status Word, bit 18 high
User flash program (switch 8 ON)	All LEDs are OFF	
Step loss	LED rosso acceso fisso	ERR_FAT = 1
Over temperature	Red LED blinking 5 Hz Green LED as drive ok	ERR_FAT = 2
Short circuit	Red LED blinking 0,5 Hz Green LED as drive ok	ERR_FAT = 3
Over voltage	Red LED steady lit Green LED steady lit	ERR_FAT = 4
Programmed data error	Green LED and red LED blinking together at 5 Hz	ERR_FAT = 5
Open motor cables	Green LED and red LED blink together at 0.5 Hz	ERR_FAT = 6 or 9
Under voltage	Red LED blinks every 3 seconds Green LED as drive ok	ERR_FAT = 7

Tab. 8 – Diagnostic