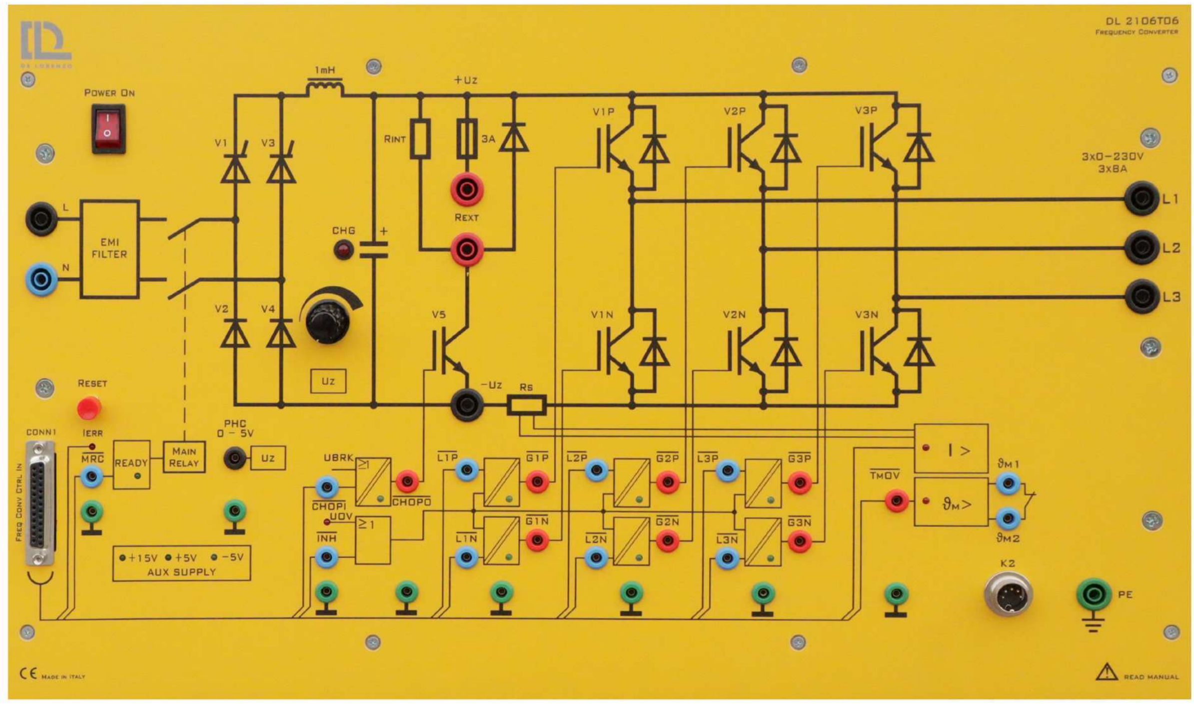
8. DL 2106T06 - FREQUENCY CONVERTER

This module is a power electronics based converter that converts alternating current at one frequency to alternating current at another frequency. It can change the voltage as well. It is widely used in industry.

This module is used in this laboratory to demonstrate basic operating principles, modulation and control methods based on motor drive applications.



The module consists of rectifier, DC link, inverter, and control system.

1. Rectifier

The rectifier contains an EMI filter on the input side, a main relay, a half-controlled diode-thyristor based rectifier.

The 2 terminals at the input connect the AC power supply to the frequency converter.

The EMI filter reduces the pollution of the frequency converter to the input AC power.

The relay connects / disconnects the input AC power supply to / from the rectifier.

The half-controlled rectifier converts the alternating current to direct and charges the DC link.

Parameters:
- Max. input voltage: 230 VAC.
- 50/60 Hz compatible.
- Synchronization time: 3 s

Note:
The synchronization time is the time required for the module to complete the synchronization for the half-controlled rectifier. It starts from the moment when the relay connects the input AC power supply to the rectifier. During these 3 seconds, the triggering angle of the rectifier must be kept at 180 degrees, i.e., the charging command of the DC link must be minimum.

Controllable components:

- relay's on and off,
- triggering angle of the rectifier, i.e., the charging command of the DC link.
  - Knob (leave 'PHC' open).
  - Analogue signal @ PHC (set the knob to the leftmost).

Note:
The relay is not designed to cut off current, so before switching off the relay, reduce the conducting current of the relay to the minimum.
It is also suggested to ensure, before switching on the relay, that the conducting current starts from the minimum. For example, set the triggering angle of the rectifier to the minimum.

2. DC link

The DC link contains a smoothing inductor, a group of DC capacitors with a charge indicator, a resistor-switch discharging system, and a DC link current sensor on the output side.

The DC link can be charged by:

- The input rectifier through a smoothing inductor or an external DC power supply.
- The braking energy through the output inverter.

Note:
The charging process of the DC link should be done gradually.
The red indicator 'CHG' indicates the amount of charge.

Note:
The indicator light must be off at the end of each experiment or before changing cables to ensure safety.

The resistor-switch discharging system is controlled in 2 ways:

- Control by command: users control the switch to remove the DC link charge. This is usually done at the end of each experiment or before changing cables to ensure safety.

Note:
This operation must not occur while the rectifier is still charging the DC link, because the long-term overcurrent will burn the discharging resistor!
Therefore, be sure to do this only after turning off the rectifier as well as the input side power.
Once the charge is exhausted, remove the discharging command.

- Overvoltage automatic trigger: users have no access to this control. It will be done automatically to protect the DC capacitors from overvoltage in case of fast braking. The protection has hysteresis to prevent false triggering and frequent triggering.

A DC link current sensor protects the output inverter from short-circuit or overcurrent.

Parameters:

- Max. DC voltage: 400 VDC.
- Instant DC link overcurrent protection threshold: ±14 A.
- Internal discharging resistor: 68 ohm.
- User controlled DC link discharge time: 5 to 30 s.
- Automatic discharge @ overvoltage:
  - upper hysteresis: around 400 V
  - lower hysteresis: around 350 V

Controllable components:

- User controlled DC link discharge process.
- External discharging resistor.

3. Output 3-phase inverter

The output inverter is a 6-IGBT-based bridge, supplied by the DC link. It is controlled to generate AC output power with the desired voltage amplitude, frequency, and shape of the flux inside the motor.

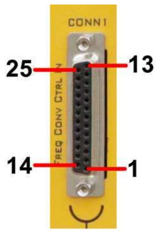
Parameters:

- output voltage range: 0 – 230 VAC
- max. output current: 8 A

4. Control signals

The control signals include digital control by external controller, manual digital control on the front panel, protection and exception handling, and sensors.

Digital control by external controller



Pin	signal name	description	pin type	range	feature
1	L1P_C	control for V1P	DI	0/5 V	high effective
2	L2P_C	control for V2P	DI	0/5 V	high effective
3	L3P_C	control for V3P	DI	0/5 V	high effective
5	DGND	digital ground			
6	Relay_C	control for relay	DI	0/5 V	high effective
7	Disch_C	control for discharge	DI	0/5 V	high effective
8	DGND	digital ground			
11	AGND	analogue ground			
12	AGND	analogue ground			
13	AGND	analogue ground			
14	L1N_C	control for V1N	DI	0/5 V	high effective
15	L2N_C	control for V2N	DI	0/5 V	high effective
16	L3N_C	control for V3N	DI	0/5 V	high effective
17	\Fault	fault signal output	DO	0/5V	low effective
23	Encoder	encoder sensor output	AO	1000 rpm/V	unipolar
24	Iz	DC link current sensor output	AO	1.9512 A/V	bipolar
25	Uz	DC link voltage sensor output	AO	45.79 V/V	

Manual digital control on the front panel

Terminal	descprition	pin type	control / protection method
$\overline{\text{MRC}}$	control for relay	DI	ground the terminal to enable
$\overline{\text{CHOPI}}$	control for discharge	DI	ground the terminal to enable
$\overline{\text{INH}}$	inverter control inhibition	DI	ground the terminal to enable
$\overline{\text{L1P}}$	control for V1P	DI	ground the terminal to enable
$\overline{\text{L2P}}$	control for V2P	DI	ground the terminal to enable
$\overline{\text{L3P}}$	control for V3P	DI	ground the terminal to enable
$\overline{\text{L1N}}$	control for V1N	DI	ground the terminal to enable
$\overline{\text{L2N}}$	control for V2N	DI	ground the terminal to enable
$\overline{\text{L3N}}$	control for V3N	DI	ground the terminal to enable
PHC	phase control for rectifier	AI	[0, 5] V results in [180, 0] deg. Their correspondence is not linear.
ΘM1, 2	NC thermal switch connector	CONN	open circuit means overtemperature
K2	Power supply and receiver of the encoder of DL 10400	CONN	

Indicators and output terminals

terminal / LED	description	pin type	property
READY	relay status	status LED	READY = MRC + Relay_C
$\overline{\text{CHOPO}}$	manual discharge switch status	status LED & output terminal	$\overline{\text{CHOPO}}$ = $\overline{\text{CHOPI}}$ * $\overline{\text{Disch\_C}}$
UOV	DC link overvoltage	warning LED	temporary warning
$\overline{\text{GIP}}$	V1P status	status LED	can be turned on only when: 1) no DC link overvoltage 2) no inverter inhibition 3) no fault signal 4) V1N is not turned on
		output terminal	LED on: low LED off: high
$\overline{\text{G1N}}$	V1N status	status LED	can be turned on only when: 1) no DC link overvoltage 2) no inverter inhibition 3) no fault signal 4) V1P is not turned on
		output terminal	LED on: low LED off: high
ΘM >	overtemperature indicator	fault LED	temporary fault
$\overline{\text{TMOV}}$	overtemperature signal	output terminal	LED on: low LED off: high
I >	DC link overcurrent indicator	fault LED	1) real overcurrent detected: permanent fault, cleared by Reset 2) prediction of overcurrent by knowing the 2 IGBTs of the same leg are turned on: temporary fault
Ierr	module failure indicator	fault LED	permanent fault, cleared by Reset 1) real overcurrent 2) overtemperature