PRODUCT DESCRIPTION

The ICP series inverters are devices for:

- Convert the three phase alternate voltage of fixed voltage and frequency into a variable alternate voltage of amplitude and frequency coming from reference input or
- Convert the direct current input voltage into a variable alternate voltage of amplitude and frequency coming from reference input.

Depending on the inverter order number, is possible to connect 2 phase or 3 phase balanced load or a 3 phase unbalanced load like stirrer or big inductors.
When a 3 phase balanced load like rotary stirrer as to be energized, the 3 phase inverter ICP type has to be used.
When a 3 phase unbalanced load like linear stirrer as to be energized, is mandatory to use the special inverter with 4 output igbt branch, in this case the 4th phase has to be connected to the load neutral wire, and the inverter is ICPL type.

Modifying the current and the frequency in the stirrer with the inverter, a magnetic field with a different rotation speed and strength will be generated; in this way is possible to apply this force to the steel during the casting phase; the stirring force applied to the steel will give a better quality to the final product.

The internal control of the inverter can work normally with the current feedback, taking this information from the current sensor inside the inverter and comparing this with the reference current from 0 to Inom (nominal current of the inverter): the error current is given to a current regulator that rise or lower the output voltage of the inverter in way of applying an output current equal to the current reference.
The internal vector control can perform a high precision in the current regulator with a good stability.

The internal parameter of the inverter can be modified with the inverter operator panel PU400 or with the diagnostic program via PC.

The inverter can work with 3 different operating mode:

Service	(The command and reference are given from the internal operator panel PU400, this working mode is reserved to SISTEM POWER personnel),
Digital	(The command and reference are given from the digital and analog input),
Profibus	(The command and reference are given from the Main PLC by the HMI supervisor directly to the profibus board present in the control board).

The inverter can supply a three phase voltage with a variable frequency from fmin to fmax Hz and a variable current from 0 to Inom (A) for the stirrer, the fmin, fmax, Inom parameters depends from the ICP inverter order code.

The commands that is possible to apply to the inverter are:
PRECHARGE ON, PRECHARGE OFF command,
START, STOP command,
RESET command.

When a PRECHARGE ON command is performed, the internal control of the inverter will close the precharge contactor, then when the voltage has risen above the Precharge level (80% of the final value), the control will close the main contactor and the precharge procedure will be finished, the inverter is in READY status.
When the inverter is in READY status, then is possible to START it giving the START command, in this way the control will enable the output pulse, giving a correct output voltage for having the required output current using the Space Vector modulator, in this way is possible to obtain in the inverter output a voltage up to 96% of the incoming line voltage.

When the inverter is in START condition, will be possible to STOP it giving the STOP command, in this case the inverter will perform the ramp down voltage and after will disable the output power to the stirrer.

When the inverter is in READY status, the is possible to put the inverter in NOT READY status giving the PRECHARGE OFF command, in this way the main and precharge contactor will be opened.

The PRECHARGE ON procedure will be enabled only when the inverter is without fault,
From the START condition the inverter will switch in STOP status when a fault condition occurs.
The fault are resumed below:

Driver fault of phase U, V, W (or short-circuit)
Overcurrent of phase U, V, W,
Overvoltage of DC link,
Undervoltage of DC link,
Inverter overtemperature,
External fault from digital input (coming from the inverter connector X27:12,13, X28:3 ÷ 14),
External fault from analog input (coming from the inverter connector X18:1,2, X18:4,5, X22:1,2, X22:3,4, X20:1,2).

For protect the Stirrer an insulation earth leakage monitor is present; this control (if present and enabled) perform the earth leakage measure of the output load (stirrer), this function can be performed:

- Never,
- Each time the inverter switch from Preset ON state to Start State,

When the earth leakage is less than a minimum value, a warning will be generated.
Also is present an unbalance current monitoring, in this way if the real current is different from the setpoint current for more than a specified level (default value 30 A) for 15 seconds, a warning will be generated.
if the real current is different from the setpoint current for more than a specified level (default value 50 A) for 20 seconds, a fault will be generated.
In this way is possible to monitor if the stirrer or the cable has some problems.

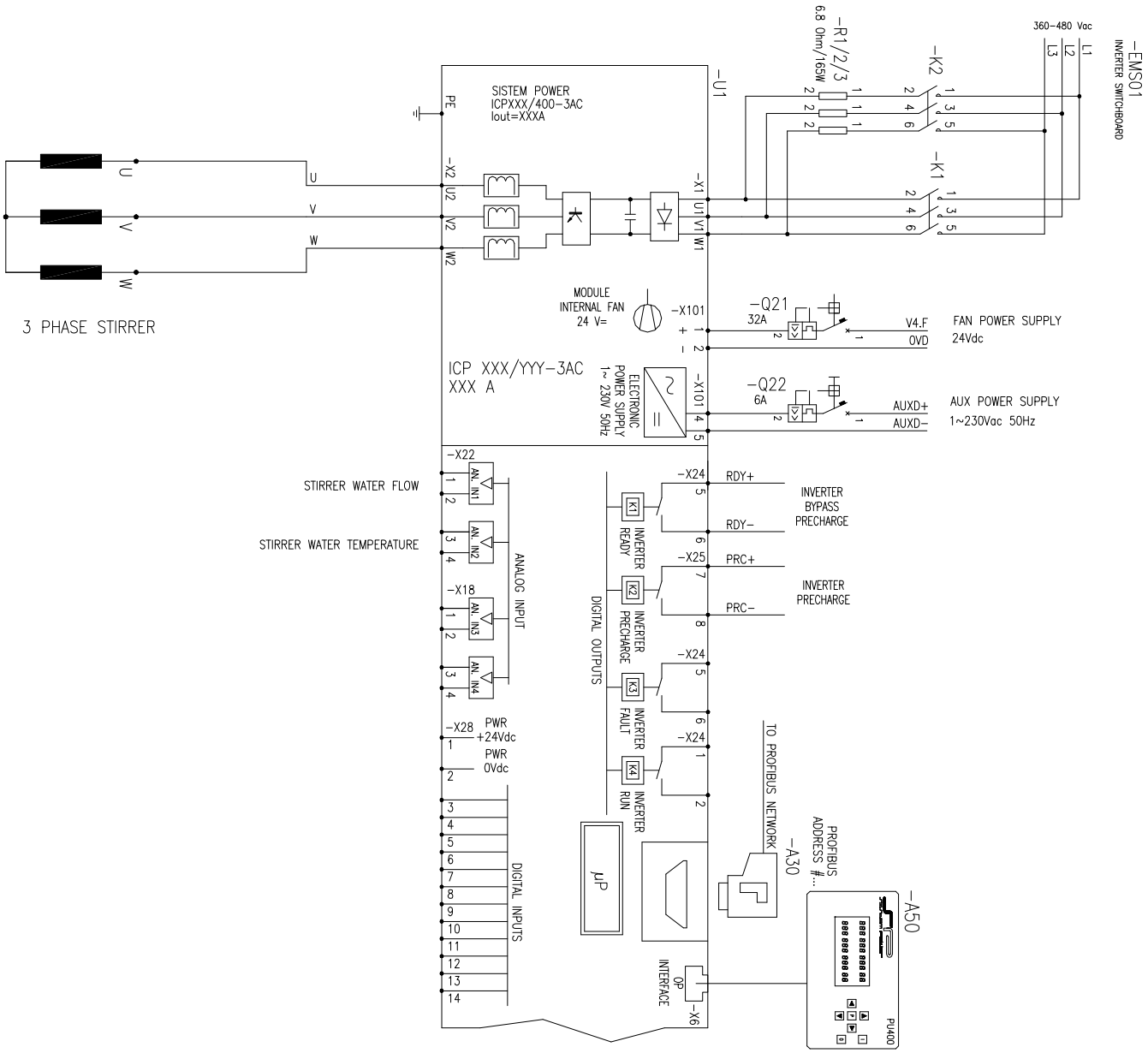
Another function present in the inverter is the alternate cycle, in this mode the output current is not equal to the reference current, but is given from a positive cycle (the output magnetic field is clockwise, with a selected period) followed by a negative cycle (the output magnetic field is counter-clockwise, with a selected period).
This alternate mode can be performed by a specified command.

The ICP series inverter consists of 3 parts:

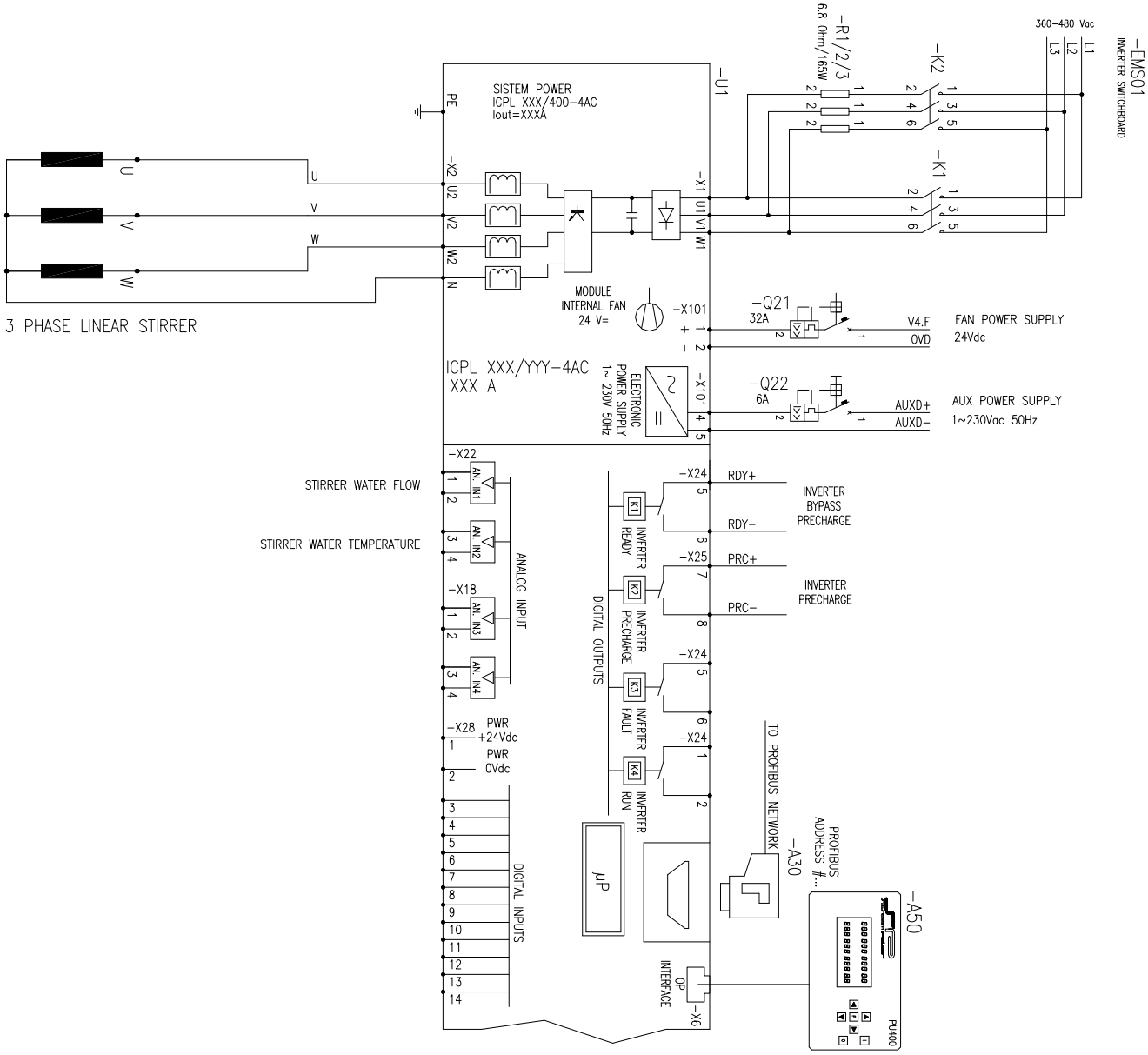
1. the AC/DC converter (for the conversion from AC to DC voltage),
2. the DC/AC converter (for the conversion from DC to AC voltage),
3. the control board.

This 3 parts are assembled in the same devices, for this reason the inverter is an AC/AC converter.

Below is possible to see the 3 phase inverter connection diagram:

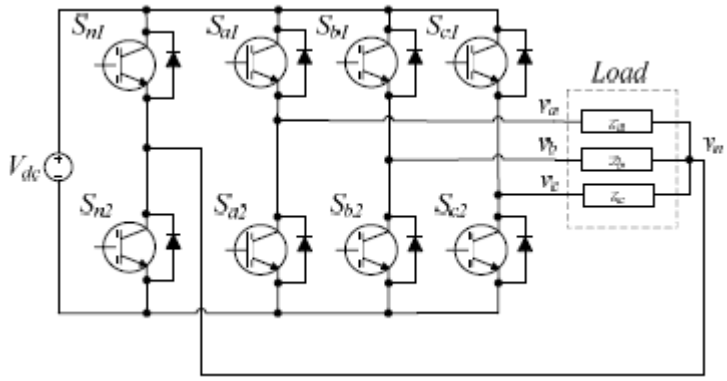


Below is possible to see the 4 phase inverter connection diagram, connected to a non-balanced 3phase load.

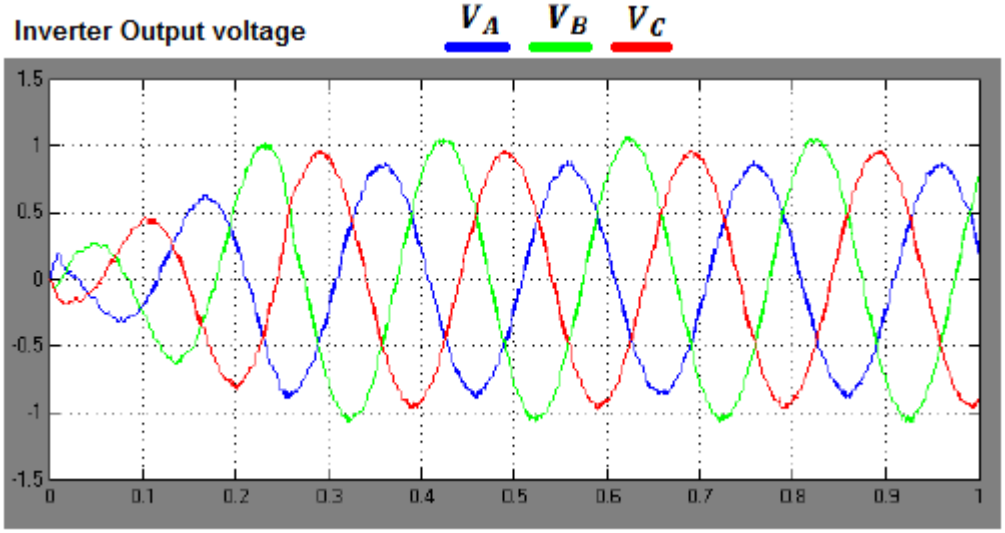


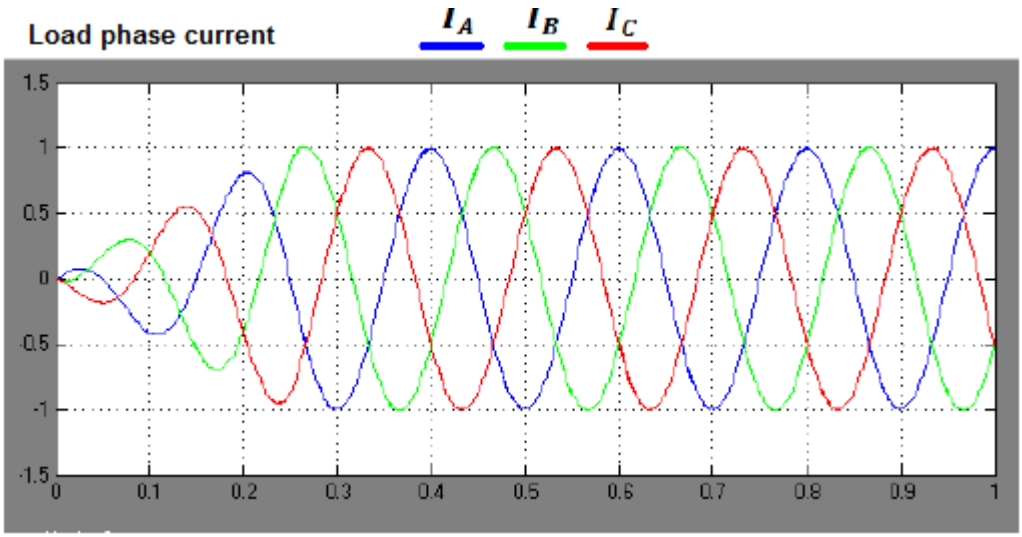
INVERTER FOR LINEAR STIRRER

Two basic stirrers commonly used in practice are the linear stirrer and the rotary stirrer.
A linear stirrer uses travelling magnetic field whereas a rotary stirrer uses rotating magnetic field to produce swirling action in the metal pool. In linear stirrer the coils are arranged in a linear fashion.
When these coils are excited by three phase currents, a travelling magnetic field is established.
The time varying field induces currents in the molten metal. The field and the current in the metal interact to establish forces in the metal and put the liquid metal into motion. A strong melt flow generates strong shear stresses, and these shear stresses will shed away the dendrites near the solid-liquid interface.
In a linear stirrer the three phase windings are distributed in space by 120° and are excited by three phase currents distributed in time by 120°. Depending on the linea r geometry of the stirrer the equivalent circuit of the load can be unbalanced. With a classic 3 phase inverter isn't possible to manage an unbalanced load without having an unbalanced current in the winding.
For obtaining a 3 phase sinusoidal current with the same amplitude and 0°, 120°, 240° phase displaceme nt, a special inverter has to be used: this converter is a three phase four leg inverter.
The main feature of a three phase inverter, with an additional neutral leg, is its ability to deal with load unbalance.
Below is possible to see the IGBT power stage topology used in this this of the inverter and its connection to the load.

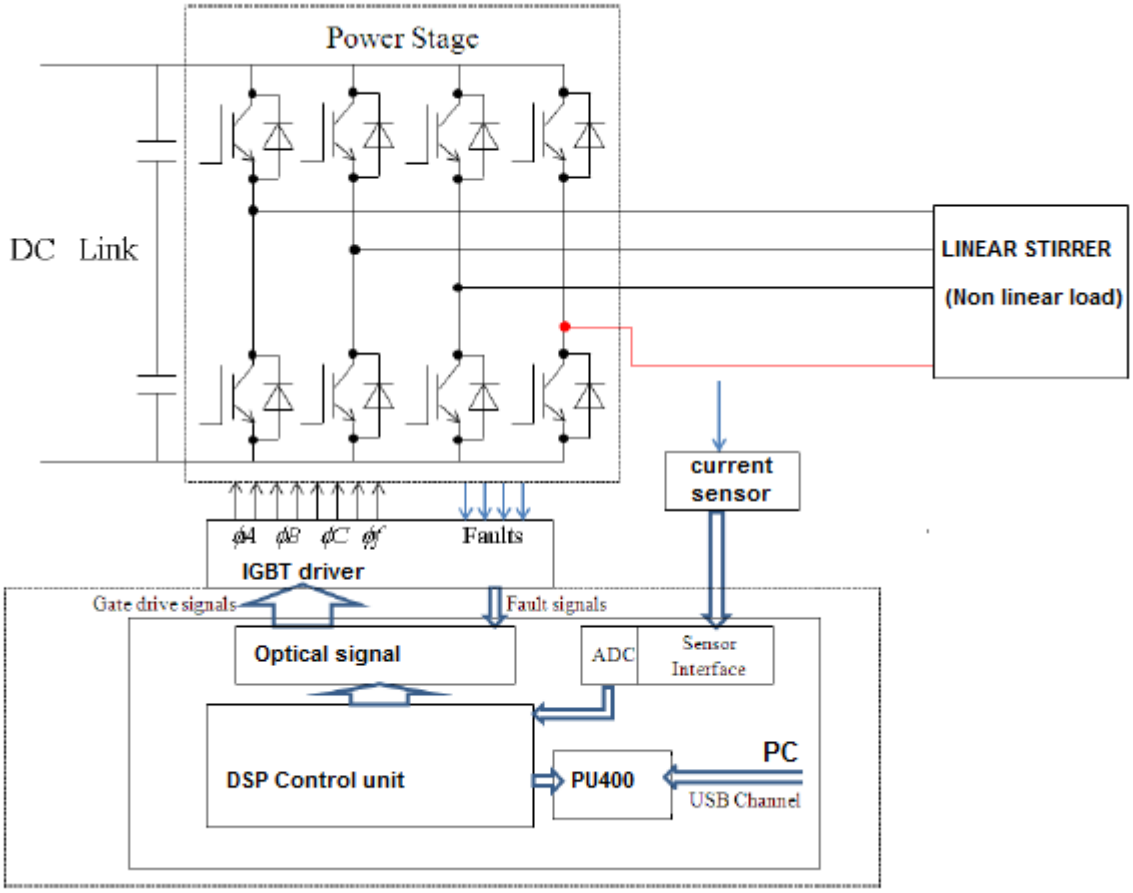


As is possible to see a 4th branch is used for connect the neutral point of the load to the 4th phase output.
This topology is known to produce balanced output current even under unbalanced load conditions. The topology is similar to the three-leg inverter with the fourth leg being connected either to the negative rail or to the positive rail, this give the flexibility to control the neutral voltage and hence produces balanced voltages across the load.
Inside the ICPL inverter is present the three phase inverter with the fourth leg.
Here below is possible to see the voltage waveform and the current waveform where an unbalanced load is connected to a three phase four leg inverter with a modified 3D SVPWM scheme.





Here below is possible to see the three phase four leg inverter control system based on Dsp.



TECHNICAL FEATURES

AC/AC INVERTER

Here below is possible to see electrical output data of the AC/AC inverter when the maximum load power factor is 0.2.

ICP CODE	Module Number	Dimension (lenght x height x depth) mm	AC Input voltage (V)	AC Input current (Arms)	Nominal Output Current (Arms)	Input Fuse Size (Arms)	Nominal Input Power (kW)	Weight (Kg)	Airflow (mc/h)	Power loss (kW)
ICP 400/400-3A	1	585x1225x445	360 - 480	120	400	200	60	250	1300	1,5
ICP 550/400-3A	1	686x1600x492	360 - 480	160	550	250	80	330	2200	2
ICP 800/400-3A	1	686x1770x492	360 - 480	230	800	315	120	340	2200	2,5
ICP 1100/400-3A	2	1372x1600x492	360 - 480	2 x 160	2 x 550	2 x 400	160	660	4400	3,5
ICP 1500/400-3A	2	1372x1770x492	360 - 480	2 x 220	2 x 750	2 x 500	230	680	4400	4,5
ICP 400/600-3A	1	686x1225x532	540 - 760	120	400	315	90	350	1300	1,8
ICP 550/600-3A	1	686x1600x532	540 - 760	160	550	400	120	390	2200	2,3
ICP 800/600-3A	1	686x1770x532	540 - 760	230	800	500	180	400	2200	2,8
ICP 1100/600-3A	2	1372x1600x532	540 - 760	2 x 160	2 x 550	2 x 400	240	780	4400	4,5
ICP 1500/600-3A	2	1372x1770x532	540 - 760	2 x 220	2 x 750	2 x 500	350	800	4400	5
ICPL 400/400-4A	1	585x1450x445	360 - 480	120	400	200	70	270	1300	1,8
ICPL 550/400-4A	1	686x1850x492	360 - 480	160	550	250	100	400	2200	2,3
ICPL 800/400-4A	1	686x2070x492	360 - 480	230	800	315	140	410	2200	2,8
ICPL 400/600-4A	1	686x1450x532	540 - 760	120	400	315	110	420	2200	2
ICPL 550/600-4A	1	686x1850x532	540 - 760	160	550	400	150	460	2200	2,5
ICPL 800/600-4A	1	686x2070x532	540 - 760	230	800	500	210	470	2200	3

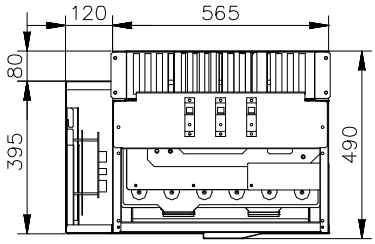
Here below is possible to see electrical output data of the AC/AC inverter when the maximum load power factor is 0.3.

ICP CODE	Module Number	Dimension (lenght x height x depth) mm	AC Input voltage (V)	AC Input current (Arms)	Nominal Output Current (Arms)	Input Fuse Size (Arms)	Nominal Input Power (kW)	Weight (Kg)	Airflow (mc/h)	Power loss (kW)
ICP 400/400-3A	1	585x1225x445	360 - 480	180	400	315	90	250	1300	2
ICP 550/400-3A	1	686x1600x492	360 - 480	240	550	400	120	330	2200	2.5
ICP 800/400-3A	1	686x1770x492	360 - 480	350	800	500	180	340	2200	3
ICP 1100/400-3A	2	1372x1600x492	360 - 480	2 x 240	2 x 550	2 x 400	240	660	4400	5
ICP 1500/400-3A	2	1372x1770x492	360 - 480	2 x 330	2 x 750	2 x 500	350	680	4400	6
ICP 400/600-3A	1	686x1225x532	540 - 760	180	400	315	130	350	1300	2,3
ICP 550/600-3A	1	686x1600x532	540 - 760	240	550	400	180	390	2200	2,8
ICP 800/600-3A	1	686x1770x532	540 - 760	350	800	500	265	400	2200	3,3
ICP 1100/600-3A	2	1372x1600x532	540 - 760	2 x 240	2 x 550	2 x 400	360	780	4400	5,4
ICP 1500/600-3A	2	1372x1770x532	540 - 760	2 x 350	2 x 750	2 x 500	510	800	4400	6,4
ICPL 400/400-4A	1	585x1450x445	360 - 480	180	400	315	110	270	1300	2,3
ICPL 550/400-4A	1	686x1850x492	360 - 480	240	550	400	150	400	2200	2,5
ICPL 800/400-4A	1	686x2070x492	360 - 480	350	800	500	210	410	2200	3
ICPL 400/600-4A	1	686x1450x532	540 - 760	180	400	315	160	420	2200	2,3
ICPL 550/600-4A	1	686x1850x532	540 - 760	240	550	400	220	460	2200	2,8
ICPL 800/600-4A	1	686x2070x532	540 - 760	350	800	500	320	470	2200	3,3

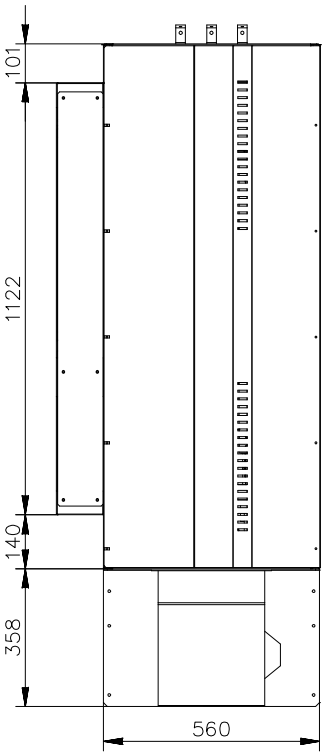
	Common electrical data
Auxiliary voltage 1 [V] Electronic supply For power module number 1	1AC, 200-245 Vac, 50Hz or 60Hz 1.5A
Auxiliary voltage 2 [V] Digital input supply	24 V, 0.5 A
Fan voltage [V] For power module number 1	18-28 Vdc 10 A for 400A inverter, 18-28 Vdc 17 A for 550A inverter, 360-440 Vac 3phase 3.4A for 800 A inverter
Auxiliary voltage 1 [V] Electronic supply For power module number 2 (if present)	1AC, 200-245 Vac, 50Hz or 60Hz 1.5A
Fan voltage [V] For power module number 2 (if present)	18-28 Vdc 17 A for 1100A 360-440 Vac 3phase 3.4A for 1500 A inverter
IGBT Switching frequency [kHz]	0.5, 0.75, 1, 1.25, 1.5
Modulation type	2 level Space Vector
Source command	3 (local, digital/analog input, profibus)
Profibus interchange word number	16 IN, 16 OUT
Profibus network speed (Mbaud)	0.5, 1.5, 3, 6, 12
External digital input	14
External relay output	3
External analog input (4..20mA or 0..10V)	5 (stirrer water flow, stirrer water temperature, water pressure, water conductivity, water inlet temperature)
External analog output (0..10V)	4

Below is possible to see the external layout of the inverter ICP 800/600-3A

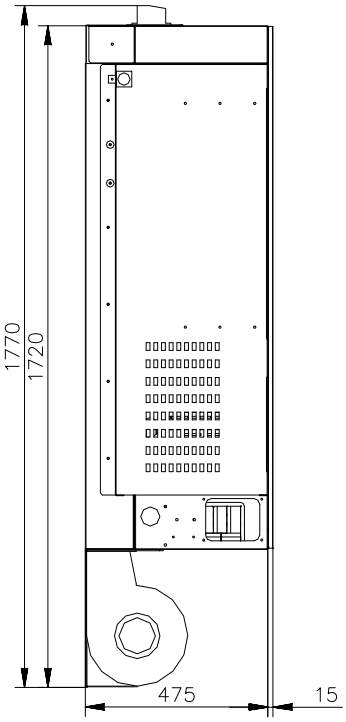
TOP VIEW

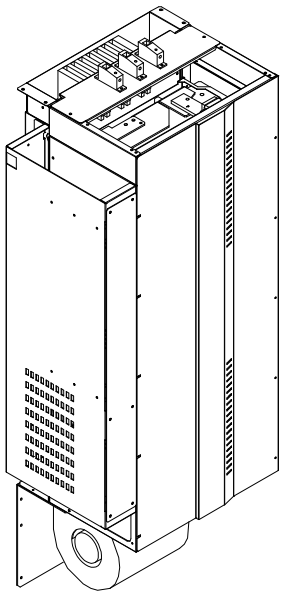


FRONT VIEW



LATERAL VIEW (LEFT)





Below is possible to see the external layout of the inverter ICP 800/600-4A