AMPLIACION
MANUAL DE FUNCIONAMIENTO Y MANTENIMIENTO DE EQUIPOS DE PRESIÓN CON VARIADOR DE FRECUENCIA
EASY VARIO-SYSTEM

CE

BOMBAS SACI CONTROLS

BADALONA – LA CORUÑA

GUIA RAPIDA DE PUESTA EN MARCHA

El objetivo de este manual es explicar como poner en marcha por primera vez el equipo Easy Vario System.

El variador se entrega con la programación estándar de fabrica y se debe proceder a su puesta marcha, para ello debemos introducir tres parámetros básicos.

EQUIPO CON UN VARIADOR:

Estos tres parámetros básicos serán: la intensidad nominal del motor, en caso necesario, el cambio de sentido de giro del motor y la configuración de la presión a la cual se quiere trabajar

Una vez se da tensión al equipo, en el indicador luminoso aparece escrito las letras “ZF”, y al cabo de unos segundos aparece la condición de error “EC”.

Es entonces cuando indicaremos la intensidad nominal. Recordamos que aun que tengamos alimentación monofásica, el consumo será del T220V que esta conectado el motor.
Pulsamos a la vez las teclas MODE, SET y – (MENOS), hasta que aparezca en el indicador “rC”, y con los botones “+” “-“, aumentamos o reducimos el valor del parámetro.

Pulsando SET, para salir del menú o MODE para hacer correr el menú, se activa el valor de corriente configurado, y desbloqueamos el variador.

Si hemos pulsado SET, habremos salido del menú y desde allí, apretaremos a la vez las teclas MODE, SET y – (MENOS), en el cambio de menú pulsaremos MODE, hasta visualizar el parámetro “rt”, y con las teclas “+” “-“, cambiamos el sentido de rotación si es necesario.

Para configurar la presión de consigna, desde el estado de funcionamiento normal, apretaremos simultáneamente los botones MODE y SET hasta que aparezca en la pantalla “SP”. Entonces con las teclas “+” “-“, aumentamos o disminuimos la presión de consigna. Pulsando SET volvemos al estado de funcionamiento normal.

EQUIPO CON DOS VARIADORES:

Si solo disponemos de un variador, con el procedimiento anteriormente explicado, el equipo queda listo para su funcionamiento. Si el caso que nos acontece es de un grupo con dos variadores, hemos de continuar para interrelacionarlos entre si.

Para ello hemos de indicar cual es el variador principal y cual el secundario, habilitar la función de trabajo en cascada, y habilitar la rotación de bombas si se desea.

Para indicar cual será el vario principal, con las teclas MODE, SET y – (MENOS), iremos al parámetro “Ad”, introduciremos 1 para el variador principal y 2 para el variador secundario.

Para habilitar el trabajo en cascada, con las teclas MODE, SET y – (MENOS), iremos al parámetro “Eb”, introduciremos 2 para activar esta función.

Para habilitar la rotación de bombas, con las teclas MODE, SET y + (MAS), iremos al parámetro “CM”, introduciremos 1 para activar esta función.

INDICE

1 INTRODUCTIÓN

El PWM 230 3basic es un dispositivo con alimentación monofásica a 220 V y es capaz de modular la velocidad de una electrobomba trifásica 220 V a fin de mantener constante la presión de una instalación hidráulica.

2 INSTALACIÓN

2.1 Conexiones hidráulicas

Instale una válvula de retención en la tubería montada antes del PWM.
A fines del funcionamiento del PWM es indiferente instalar la válvula en la aspiración o en la impulsión de la electrobomba.

La conexión hidráulica entre el PWM y la electrobomba no debe tener derivaciones. La tubería debe tener dimensiones adecuadas a la electrobomba instalada.

2.2 Conexiones eléctricas

2.2.1 Conexión a la línea de alimentación PWM 230 3basic

Conexión de entrada 220V-240V 50Hz nominales monofásica. Para versiones sin cables, la línea debe conectarse al borne “J2” de 3 vías con indicación “LINE” y flecha de entrada (véase la fig.1).

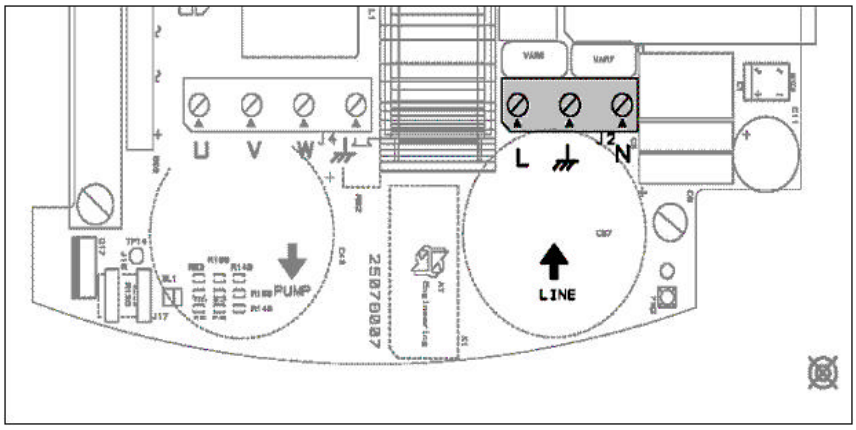

Figura 1: Borne de entrada alimentación monofásica

Si se instala una electrobomba de potencia equivalente a la potencia máxima admitida, la sección del cable de alimentación deberá ser igual o superior a

Sección de cada conductor (mm^2)	Longitud máxima de la línea (metros)
1.5	20
2.5	90

Si se instalan bombas de potencia inferior a la potencia máxima admitida, la sección de los cables de alimentación puede reducirse proporcionalmente (por ejemplo, si la potencia total es la mitad, la sección puede reducirse).
El PWM 230 3-basic está dotado de protecciones de corriente. El magnetotérmico de protección de la línea debe tener una capacidad de 10Arms.

La conexión de la línea al PWM 230 debe incluir la puesta a tierra. La resistencia de tierra total no debe superar 100 Ohm.

2.2.2 Conexiones eléctricas a la electrobomba

La tensión de alimentación del motor de la electrobomba instalada debe ser de 230V 50Hz trifásica.
El servicio conectado al PWM 230 no debe superar los 4,5 como corriente de fase.
Motores trifásicos configurados con tensiones diferentes de 230V nominales no pueden funcionar con el PWM 230. Controle las placas de conexión del motor utilizado para respetar las condiciones antedichas.

Por lo general las máquinas eléctricas trifásicas tienen 2 tipos de conexión, tal como se muestra en las figs. 2 y 3. La conexión en triángulo es aquella que se ha de utilizar para trabajar con 230V (fig. 3).

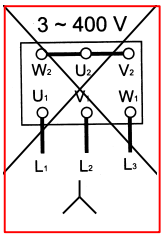

Figura 2: Conexión incorrecta

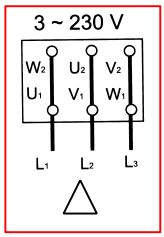

Figura 3: Conexión correcta

Una configuración incorrecta del motor eléctrico de la electrobomba en estrella, correspondiente al uso del PWM230 3-basic puede provocar la avería del mismo motor.

La conexión entre el PWM 230 3-Basic y la electrobomba se efectúa con un cable de 4 conductores (3 fases + tierra). La conexión se efectúa en el borne “J4” de 4 vías con indicación “PUMP” y con la flecha de salida (véase fig. 4). El cable debe tener una sección igual o superior a 1,5 mm^2 para cualquier longitud.

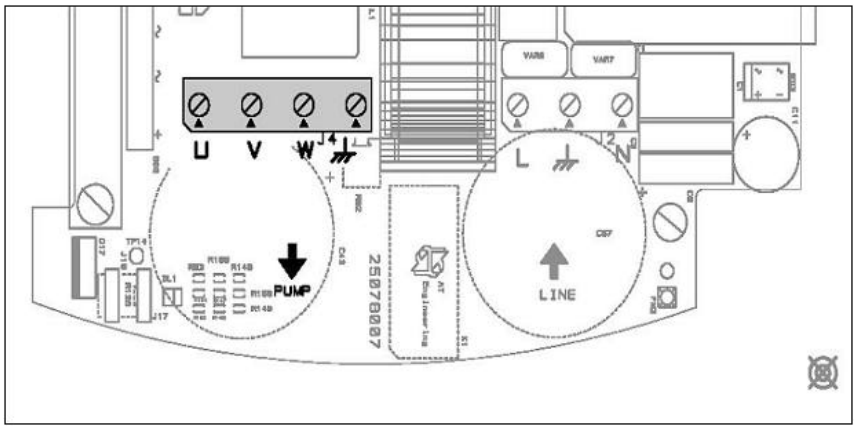

Figura 4: Borne de salida electrobomba trifásica

Una conexión incorrecta de las líneas de tierra a un borne que no sea el borne de tierra puede arruinar irremediablemente todo el equipo.

Una conexión incorrecta de la línea de alimentación en los bornes de salida destinados a la carga puede arruinar irremediablemente todo el equipo.

Una vez concluida la instalación eléctrica e hidráulica, alimente el sistema y proceda con las configuraciones descritas en el capítulo 4 OPERACIONES PARA EL PRIMER ENCENDIDO.

3 BOTONERA Y PANTALLA

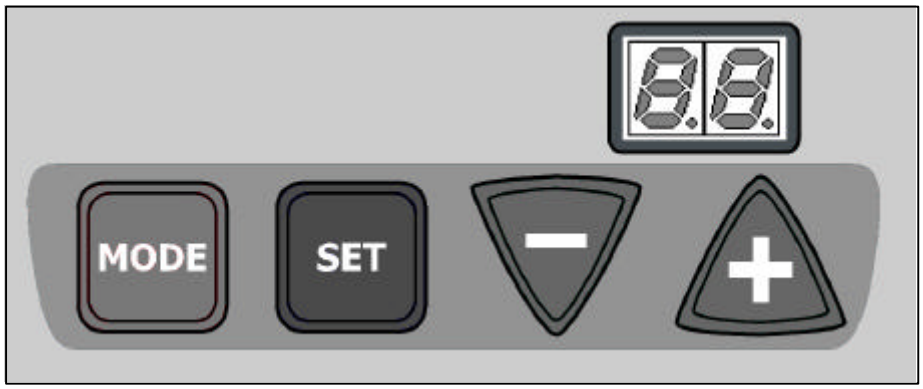

Figura 5 : Botonera-Pantalla PWM.

En la pantalla se visualizan las magnitudes y los botones del PWM. Las magnitudes están caracterizadas por un identificador alfanumérico y por el valor. El significado del identificador alfanumérico está explicado en la tabla del capítulo 5. Durante la exposición de una magnitud, aparece cíclicamente durante 1 segundo el identificador y durante 6 segundos el valor. Para facilitar las operaciones de configuración, al pulsar un botón de aumento (+ o -) se coacciona la exposición del valor.

	El botón MODE permite pasar a los elementos siguientes dentro de cada menú
	El botón SET permite salir del menú actual y volver al estado normal de visualización
	Púlselo para disminuir el parámetro actual, modificable. Cada vez que se pulsa, el valor de la magnitud se visualiza durante 6 segundos como mínimo; después aparece el identificador durante 1 segundo
	Púlselo para aumentar el parámetro actual, modificable. Cada vez que se pulsa, el valor de la magnitud se visualiza durante 6 segundos como mínimo; después aparece el identificador durante 1 segundo

Nota: Al pulsar el botón + o el botón - la magnitud seleccionada se modifica y memoriza inmediatamente en la memoria permanente (EEprom). El apagado, incluso accidental, de la máquina durante esta etapa no provoca la pérdida del parámetro configurado. El botón SET sirve únicamente para volver a visualizar el estado de la máquina. No es fundamental pulsar el botón SET para memorizar las modificaciones hechas.

4 OPERACIONES A LLEVAR A CABO PARA EL PRIMER ENCENDIDO

Después de haber efectuado correctamente las operaciones de montaje de la instalación hidráulica y eléctrica, se puede alimentar el PWM.
En la pantalla aparecerá escrito "ZF" .

1. Desde el estado normal de funcionamiento pulse “MODE” & “SET” & “-“ hasta que en la pantalla aparezca “rt”

2. Configuración del sentido de rotación.
   En estas condiciones los botones + y - permiten invertir el sentido de rotación del motor (función activa incluso con el motor encendido). El sentido de rotación está indicado por una flecha en la carcasa del motor de la electrobomba. Si no fuera posible observar el sentido de rotación del motor, proceda de la siguiente manera:

   - Pulse el botón SET para colocarse en el menú de visualización normal (en la pantalla aparece "Go" o "Sb" salvo que no hayan intervenido condiciones de error o de bloqueo).
   - Abra un elemento de servicio y observe la frecuencia (pulse el botón MODE, en la pantalla se alternan "Fr" y el valor de la frecuencia).
   - Sin cambiar el suministro, cambie el parámetro rt (como descrito en el punto 2), pulse SET y observe nuevamente la frecuencia Fr.
   - El parámetro rt correcto es aquel que requiere, a igualdad de suministro, una frecuencia Fr más baja.

3. Configuración de la presión de setpoint.
   Desde el estado de funcionamiento normal, mantenga pulsados simultáneamente los botones MODE y SET hasta que en la pantalla aparezca “SP”. En estas condiciones, los botones “+” y “-“ permiten aumentar y disminuir respectivamente el valor de la presión deseada.
   El rango de regulación abarca de 1,0 a 9,0 bares.
   Pulse SET para volver al estado de funcionamiento normal.

5 VISUALIZACIONES EN LA PANTALLA

Identificador	Descripción
Indicaciones en la pantalla durante el funcionamiento normal	
Go	Electrobomba encendida
Sb	Electrobomba apagada
Condiciones de error y de estado	
bL	Bloqueo por falta de agua
oF	Bloqueo por sobrecorriente en los terminales de salida
SC	Bloqueo por cortocircuito en las fases de salida
ot	Bloqueo por recalentamiento de los terminales de potencia
E0...E7	Error interno 0...7
Visualización de las magnitudes principales (botón MODE)	
Fr	Visualización de la frecuencia de rotación actual [Hz]
UP	Visualización de la presión [en bares] (duplicado en mod. manual)
UE	Visualización de la versión del software instalado en el equipo

Visualizaciones y configuraciones usuario (botones MODE & SET 2 segundos)	
SP	Configuración de la presión de setpoint [bar]
Visualizaciones y configuraciones instalador [botones MODE & SET & - 5 segundos]	
rt	Configuración del sentido de rotación (duplicado en mod. manual)
od	Configuración de la modalidad de funcionamiento del PWM
rP	Configuración de la caída de presión por reencendido [bar]
Visualizaciones y configuraciones asistencia técnica (botones MODE & SET & + 5 segundos)	
Tb	Configuración del tiempo de espera del bloqueo por falta de agua [s]
GP	Configuración de la ganancia del coeficiente proporcional del PI
GI	Configuración de la ganancia del coeficiente integral del PI
FS	Configuración de la frecuencia máxima de rotación de la electrobomba [Hz]
dP	Configuración del diferencial de presión con flujos bajos [bar]
Ft	Configuración del umbral de flujo bajo
AE	Habilitación de la función anticongelante
MONITOR [botones SET & - durante 2 seg]	
UF	Visualización del flujo (duplicado en mod. manual)
ZF	Visualización del cero flujo (duplicado en mod. manual)
FM	Visualización de la frecuencia máxima de rotación [Hz]
tE	Visualización de la temperatura de los terminales de potencia [°C]
GS	Visualiza el estado de funcionamiento
FF	Visualización del historial de errores y bloqueos

Acceso a la modalidad manual [botones SET & + & - 5 segundos]	
FP	Configuración de la frecuencia de prueba en ciclo manual [Hz] = al valor FS configurado
UP	Visualización de la presión [bar]
rT	Configuración del sentido de rotación.
UF	Visualización del flujo
ZF	Visualización del cero flujo
Reajuste de las configuraciones de fábrica (botones SET & + durante 2 seg. en el encendido)	
EE	Escritura y lectura en EEprom de las configuraciones de fábrica
Reajuste del sistema [botones MODE & SET & + & -]	
ZF	Reajuste general (ZF aparece cuando se sale del reajuste y el sistema se reinicia)

6 SIGNIFICADO DE CADA PARÁMETRO

6.1 Parámetros configurables

6.1.1 Parámetros para el usuario (botones de acceso MODE & SET)

Atención: Si durante esta etapa se produce un error o un problema de funcionamiento, la pantalla no se modifica. Según el tipo de error, la electrobomba puede apagarse. Sin embargo es posible efectuar la calibración deseada. Para saber el tipo de error es necesario volver a la modalidad en que se ve el estado de funcionamiento, pulsando el botón SET.

6.1.1.1 SP: Configuración de la presión de setpoint (valor preconfigurado 3,0 bares)

Desde el estado de funcionamiento normal, mantenga pulsados simultáneamente los botones MODE y SET hasta que en la pantalla aparezca “SP”. En estas condiciones los botones + y – permiten aumentar y disminuir respectivamente el valor de la presión deseada.
El rango de regulación abarca de 1,0 a 9,0 bares.
Pulse SET para volver al estado de funcionamiento normal.

El PWM, además de la presión de servicio, también permite configurar otros dos valores:
"rP": indica en metros la disminución de presión que provoca el arranque de la bomba (véase párrafo 6.1.2.4)
"dP": indica en metros la disminución de presión deseada, respecto de "SP", con flujos bajos (véase párrafo 6.1.3.5)
Los tres parámetros están asociados entre sí según el siguiente esquema.

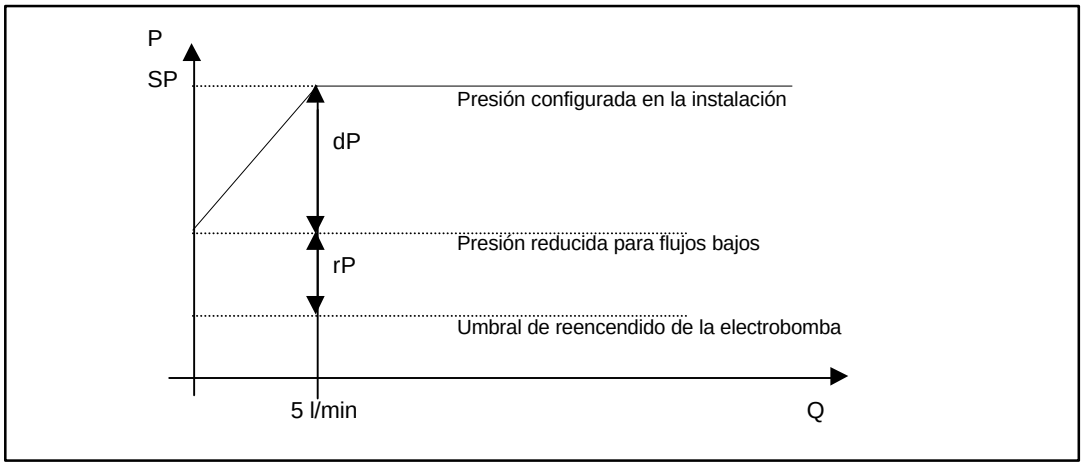

Figura 15: Esquema de regulación de la presión en función del flujo

Ejemplo: SP = 4,5 bares; dP = 1,0 bar; rP = 0,7 bar:
Durante el funcionamiento normal, la instalación será presurizada en 4,5 bares. Si los flujos son bajos (pérdidas) la instalación será presurizada en 3,5 bares. La electrobomba arranca cuando la presión desciende por debajo de 2,8 bares.

Para la selección de los valores de rP, el PWM está dotado de un sistema de limitación que se activa cuando se configuran setpoints de presión inferiores a 2,3 bares. En este caso, rP está limitado en función de la combinación de los valores de SP y de dP para obtener una presión de arranque mínima equivalente a 0,3 bar. Por ejemplo, si SP valía 3,0, dP valía 1,0 y rP valía 1,0, después de haber colocado SP en 2,2, rP valdrá 0,9.

Para la selección de los valores de dP, el PWM está dotado de un sistema de limitación que se activa cuando se configuran setpoints de presión inferiores a 2,0 bares. En este caso, dP se limita a 0,5. Por ejemplo, si SP valía 3,0 y dP valía 1,0, después que Sp se ha colocado en 1,9, dP valdrá 0,5. Por el contrario, si dP era inferior a 0,5 (por ejemplo valía 0,3), durante el paso de SP = 3,0 a SP = 1,9, el valor de dP no se modificará. De la misma manera, si ya estaba configurado un valor de setpoint inferior a 2,0 bares, en la configuración de dP no se admitirá alcanzar valores superiores a 0,5 bar.

6.1.2 Parámetros para el instalador (botones de acceso MODE & SET & -)

Atención: Si durante esta etapa se produce un error o un problema de funcionamiento, la pantalla no se modifica. Según el tipo de error, la electrobomba puede apagarse. Sin embargo es posible efectuar la calibración deseada. Para saber el tipo de error es necesario volver a la modalidad en que se ve el estado de funcionamiento, pulsando el botón SET.

Desde el estado de funcionamiento normal, mantenga pulsados simultáneamente los botones “MODE” & “SET” & “-“ (menos) hasta que en la pantalla aparezca “rt”. En estas condiciones los botones + y - permiten aumentar y disminuir respectivamente el valor del parámetro, mientras que el botón MODE permite pasar al parámetro siguiente de manera cíclica.
Pulse SET para volver al estado de funcionamiento normal.

6.1.2.1 rt: Configuración del sentido de rotación (valor preconfigurado 0)

Valores posibles: 0 y 1
Si el sentido de rotación de la electrobomba es incorrecto, es posible invertirlo cambiando este parámetro.
Si no fuera posible observar el sentido de rotación del motor, proceda de la siguiente manera:

- Abra un elemento de servicio y observe la frecuencia (parámetro Fr con el botón MODE desde Go/Sb).
- Sin cambiar el suministro, cambie el parámetro rt y observe de nuevo la frecuencia Fr.
- El parámetro rt correcto es aquel que requiere, a igualdad de suministro, una frecuencia Fr más baja.

6.1.2.2 od: Configuración de la modalidad de funcionamiento del PWM (valor preconfigurado 1)

Valores posibles 1 y 2
El PWM sale de fábrica con modalidad 1, es decir para trabajar sin depósitos de expansión o con depósitos pequeños. Si en proximidad del PWM hay un depósito de expansión con conexión de media pulgada o superior, es necesario pasar a la modalidad 2.

Importante: En las dos configuraciones cambian los valores de los parámetros de regulación **GP** y **GI**. Además, los valores de GP y GI configurados en modalidad 1 se encuentran en una memoria diferente de los valores de GP y GI configurados en modalidad 2. Por lo tanto, por ejemplo, el valor de GP de la modalidad 1, cuando se pasa a la modalidad 2, es sustituido por el valor de GP de la modalidad 2, pero es conservado y se lo encuentra nuevamente si se vuelve a la modalidad 1. Un mismo valor visualizado en la pantalla tiene un peso diferente en una o en la otra modalidad, porque el algoritmo de control es diferente.

6.1.2.3 rP: Configuración de la caída de presión por reencendido (valor preconfigurado 0,3 bar)

Indica (en bares) la caída de presión respecto del valor SP configurado que provoca el arranque de la bomba.
Normalmente, rP puede configurarse desde un mínimo de 0,1 a un máximo de 1,5 bar. En condiciones particulares (véase párrafo 6.1.1.1 y también la fig. 15) puede ser limitado automáticamente.

6.1.3 Visualizaciones y configuraciones asistencia técnica (botones de acceso MODE & SET & +)

6.1.3.1 tB: Configuración del tiempo de bloqueo por falta de agua (valor preconfigurado 10s)

La configuración del tiempo de espera del bloqueo por falta de agua permite seleccionar el tiempo (en segundos) utilizado por el sistema PWM para señalar la falta de agua de la electrobomba.
La modificación de este parámetro puede ser útil si se conoce un retardo entre el momento en que la electrobomba se enciende y el momento en que comienza efectivamente el suministro. Un ejemplo puede ser aquel de una instalación donde la tubería de aspiración de la electrobomba es muy larga y puede tener alguna pequeña pérdida. En este caso, podría suceder que la tubería en cuestión se vacíe, incluso si no falta agua, y que la electrobomba tarde un cierto tiempo para recargarse, suministrar flujo y presurizar la instalación.

6.1.3.2 GP: Configuración de la ganancia del coeficiente proporcional del PI

Para mantener constante la presión en la instalación, el sistema PWM realiza un control tipo PI en el error de presión detectado. Según este error, el PWM calcula la potencia a suministrar a la electrobomba. El comportamiento de este control depende de los parámetros GP y GI configurados. Para solucionar diferentes comportamientos de los diferentes tipos de instalaciones hidráulicas donde el sistema puede funcionar, el PWM permite seleccionar parámetros diferentes de aquellos configurados en fábrica.
Para la mayoría de las instalaciones, los parámetros GP y GI de fábrica son aquellos ideales. Si se produjeran problemas de regulación, dichas configuraciones pueden modificarse.

Por lo general, el valor proporcional debe aumentarse para sistemas caracterizados por elasticidad (tuberías de PVC y amplias) y disminuirse en las instalaciones rígidas (tuberías de hierro y estrechas)

6.1.3.3 GI: Configuración de la ganancia del coeficiente integral del PI

Indicativamente se puede afirmar que la presencia de grandes caídas de presión, al aumentar repentinamente el flujo, o una respuesta lenta del sistema, pueden compensarse aumentando el valor de GI. Por el contrario, al producirse “vibraciones” en la presión (oscilaciones de presión muy rápidas alrededor del valor de setpoint) puede eliminarse disminuyendo el valor de GI.

Nota: Un ejemplo típico de instalación donde esto puede suceder es aquel donde la tubería de aspiración de la electrobomba es muy larga. En este caso se puede provocar una elasticidad hidráulica que influya sobre el control PI y, por lo tanto, sobre la regulación de la presión.

Importante: Para obtener regulaciones de presión satisfactorias, por lo general hay que modificar GP y GI. En efecto, la combinación justa entre estos dos parámetros permite la regulación ideal de la presión.

6.1.3.4 FS: Configuración de la frecuencia máxima de rotación (valor preconfigurado 50Hz)

Para obtener potencias hidráulicas mayores, el motor de una electrobomba puede funcionar con un valor de frecuencia superior al valor nominal. La sobrealimentación de la electrobomba es útil para cubrir altas demandas de flujo sin que la presión de la instalación sea muy diferente de aquella configurada. Esta condición de funcionamiento no puede durar mucho tiempo porque provoca el aumento de la temperatura del motor que podría arruinarse.
Para aprovechar la sobrealimentación, el PWM permite configurar una frecuencia máxima de servicio superior a la frecuencia nominal, creando una imagen térmica del motor instalado y limitando la frecuencia máxima enviada a la electrobomba si la temperatura aumentara mucho. El valor de la frecuencia máxima configurada (FS) se logra con el motor frío y disminuye hasta 50Hz al aumentar la temperatura de los bobinados.
Por otra parte, si fuera necesario, el PWM permite configurar una frecuencia máxima de servicio inferior a la frecuencia de 50 Hz hasta un mínimo de 40Hz. En este caso, en cualquier condición de regulación, la electrobomba no será nunca alimentada con una frecuencia superior a aquella configurada.

6.1.3.5 dP: Configuración del diferencial de presión con flujos bajos (valor preconfigurado 0)

En modalidad 1, la configuración de la excursión admitida para el setpoint de presión permite seleccionar un intervalo de presiones inferior al setpoint (SP) con las que el PWM regulará en caso de flujos bajos.

La ventaja de seleccionar un dP diferente de cero es que se puede redimensionar el caudal si hubiera pérdidas en la instalación y permitir un ahorro de energía, pudiendo funcionar la electrobomba a bajas revoluciones cuando los flujos requeridos son bajos.
Los posibles valores configurables de dP son de 0 a 1,0 bar, salvo limitaciones automáticas (véase párrafo 6.1.1.1).
El PWM pasa de la condición de Stand By al encendido de la electrobomba después de que la presión en la instalación ha descendido por debajo de SP – dP – rP (véase párrafo 6.1.1.1).

6.1.3.6 Ft: Configuración del umbral de flujo bajo (valor preconfigurado 15)

El sistema PWM está dotado de un sensor de flujo. Cada vez que la electrobomba está apagada se efectúa una nueva puesta a cero. El PWM apaga la electrobomba cuando el flujo leído es inferior a “Ft”. En otras palabras, el umbral de flujo bajo es un margen de tolerancia en la lectura de ZF que asegura que la electrobomba se apague.
Para comprobar que los apagados con correctos es suficiente comparar el flujo "UF" (véase párrafo 6.2.2.1 UF: Visualización del flujo) leído con los grifos cerrados y la electrobomba en funcionamiento con el parámetro configurado "Ft".

6.1.3.7 AE: Habilitación de la función anticongelante (valor preconfigurado 1)

Hace girar el grupo motor-rodete para evitar bloqueos mecánicos.

Cuando la funcionalidad anticongelante está habilitada, si el PWM mide una temperatura muy baja con riesgo de congelación, comienza automáticamente a hacer funcionar la electrobomba a bajos números de revoluciones. Mantener el agua en movimiento reduce el riesgo de que se forme hielo en la bomba. También para el PWM, disipando energía se reduce el riesgo de rotura por hielo.

6.2 Parámetros de visualización

Desde el estado de funcionamiento normal, pulsando el botón MODE se visualizan las siguientes magnitudes:

6.2.1 Parámetros para el usuario (botones de acceso MODE)

Desde el estado de funcionamiento normal (Sb o Go en la pantalla), pulsando el botón MODE en la pantalla aparece “Fr”.
Entonces es posible visualizar todas las siguientes magnitudes en sucesión, pulsando cada vez el botón MODE.

6.2.1.1 Fr: Visualización de la frecuencia de rotación actual (en Hz)

6.2.1.2 UP: Visualización de la presión (en bar)

6.2.1.3 UE: Visualización de la versión del software instalado en el equipo

6.2.2 Menú MONITOR (botones de acceso SET & -)

Desde el estado de funcionamiento normal, mantenga pulsados simultáneamente los botones SET y - (menos) hasta que en la pantalla aparezca “UF”.
Entonces es posible visualizar todas las siguientes magnitudes en sucesión, pulsando cada vez el botón MODE.

6.2.2.1 UF: Visualización del flujo

Visualización del flujo instantáneo en escala interna no calibrada.

6.2.2.2 ZF: Visualización del cero flujo

Visualización de la lectura del sensor de flujo en el que se ha efectuado la puesta a cero (con la electrobomba apagada).
Durante el funcionamiento normal, el PWM utilizará este parámetro para apagar la electrobomba.

6.2.2.3 FM: Visualización de la frecuencia máxima de rotación (en Hz)

6.2.2.4 tE: Visualización de la temperatura de los terminales de potencia (en °C)

6.2.2.5 GS: Visualización del estado de running

SP bomba en funcionamiento para mantener la presión “SP”
AG bomba en funcionamiento para “anticongelante”

6.2.2.6 FF: Visualización del historial de los errores (+ & - para desplazar)

Existe una lista de 16 posiciones que sirve para guardar los últimos 16 errores que se hayan producido durante el funcionamiento del sistema.
Pulsando el botón – se retrocede en el historial hasta detenerse en el error más viejo, pulsando el botón + se avanza en el historial hasta detenerse en el error más reciente.
El punto decimal identifica el último error que se produjo, ordenado por tiempo.
El historial contiene 16 posiciones como máximo. Cada error nuevo es colocado en la posición correspondiente al error más reciente (punto decimal). Cada vez que se añade un error nuevo se cancela el más viejo que se encuentra al final de la lista.
El historial de los errores nunca se cancela sino que se actualiza al producirse nuevos errores.
El historial de los errores no se cancela ni reajustando ni apagando el equipo.

7 ERRORES Y BLOQUEOS

El PWM está dotado de un sistema de protección de los desperfectos de funcionamiento. Si se produjera un error, éste es señalado en la pantalla y, según el tipo de error, la electrobomba podría apagarse.
En los casos de bloqueo por falta de agua (bL), de bloqueo por sobrecorriente en los terminales de salida (oF), de bloqueo por cortocircuito directo entre las fases del borne de salida (SC), se puede intentar salir de las condiciones de error pulsando simultáneamente los botones + y -. Si la condición de error persiste, hay que eliminar el problema que ha determinado el desperfecto.

Condiciones de error	
Condiciones de error y de estado	
Indicación en la pantalla	**Descripción**
bL	Bloqueo por falta de agua
ot	Bloqueo por recalentamiento de los terminales de potencia
oF	Bloqueo por sobrecorriente en los terminales de salida
SC	Bloqueo por cortocircuito directo entre las fases del borne de salida
E0...E7	Bloque por error interno 0...7

“bL” Bloqueo por falta de agua

Si no hubiera flujo, el sistema apaga la bomba. Si la presión es inferior a aquella configurada, se señala una falta de agua.

Si se configura incorrectamente un setpoint de presión superior a la presión que la electrobomba logra suministrar durante el cierre, el sistema señala “bloqueo por falta de agua” (bL) aunque no se trate de una falta de agua. Entonces hay que bajar la presión de regulación a un valor razonable que, normalmente, no supera los 2/3 de la altura de elevación de la electrobomba instalada.

"SC" Bloqueo por cortocircuito directo entre las fases del borne de salida

El PWM está dotado de una protección contra el cortocircuito directo que se puede producir entre las fases U, V, W del borne de salida "PUMP". Cuando se señala este estado de bloqueo, se recomienda eliminar el cortocircuito presente y controlar detenidamente la integridad de los cables y de la instalación en general. Una vez concluidos estos controles, se puede intentar restablecer el funcionamiento pulsando simultáneamente los botones + y – **lo cual no produce ningún efecto hasta que no hayan pasado 10 segundos desde el instante en que se ha producido el cortocircuito.**

Cada vez que se produce un cortocircuito, un contador de eventos aumenta y se guarda en la memoria permanente (EEPROM).

¡DESPUÉS DEL CENTÉSIMO CORTOCIRCUITO, LA MÁQUINA SE BLOQUEA DE MANERA PERMANENTE Y NO SE PODRÁ DESBLOQUEAR MÁS!

7.1 Reajuste manual de las condiciones de error

En estado de error, el operador puede cancelar el error intentando nuevamente, pulsando simultáneamente los botones + y -.

7.2 Reajuste automático de las condiciones de error

Para algunos problemas de funcionamiento y algunas condiciones de bloqueo, el sistema intenta reajustar automáticamente la electrobomba.
El sistema de ayuda de reajuste concierne a:

- "bL" Bloqueo por falta de agua
- "ot" Bloqueo por recalentamiento de los terminales de potencia
- "oF" Bloqueo por sobrecorriente en los terminales de salida

Por ejemplo, si la electrobomba se bloquea por falta de agua, el PWM comienza automáticamente un procedimiento de test para comprobar si la máquina ha quedado efectivamente sin agua de manera definitiva y permanente. Si durante la secuencia de operaciones un reajuste se ejecuta correctamente (por ejemplo porque vuelve el agua) el procedimiento se interrumpe y vuelve al funcionamiento normal.

La siguiente tabla muestra las secuencias de las operaciones ejecutadas por el PWM por diferentes tipos de bloqueo.

Reajustes automáticos sobre las condiciones de error		
Indicación en la pantalla	**Descripción**	**Secuencia de reajuste automático**
bL	Bloqueo por falta de agua	- Un intento cada 10 minutos por un total de 6 intentos - Un intento cada 1 hora por un total de 24 intentos - Un intento cada 24 horas por un total de 30 intentos
ot	Bloqueo por recalentamiento de los terminales de potencia	- Se reajusta cuando la temperatura de los terminales de potencia desciende de nuevo por debajo de 65°C para el PWM 230 y por debajo de 75°C para el PWM 400 – PWM 400/7.5
oF	Bloqueo por sobrecorriente en los terminales de salida	- Un intento cada 10 minutos por un total de 6 intentos

8 ACCESO A LA MODALIDAD MANUAL DE LA MÁQUINA

Hay disponible una modalidad manual.

Atención: ¡Durante esta etapa todos los controles y los sistemas de protección del sistema PWM están deshabilitados!

Utilización de los botones.	
Botones pulsados	**Acción**
SET & + & -	Púlselos juntos durante algún instante hasta que en la pantalla aparezca MA
+	Aumenta el parámetro configurable (sólo frecuencia y sentido de rotación)
-	Disminuye el parámetro configurable (sólo frecuencia y sentido de rotación)
MODE	Se pasa al elemento siguiente del menú FP **Configuración** de la frecuencia de prueba en ciclo manual (en Hz) = al valor FS configurado UP Visualización de la presión (en bar) rt **Configuración** del sentido de rotación. UF Visualización del flujo ZF Visualización del cero flujo
MODE & -	La electrobomba funciona con la frecuencia configurada mientras se mantengan pulsados los botones
MODE & - & + (per 2 secondi)	La electrobomba sigue funcionando con la frecuencia configurada La electrobomba puede apagarse pulsando nuevamente los botones o pulsando MODE & -
SET	Púlselo para salir de la modalidad manual

Cuando se está dentro de la modalidad manual, toda la pantalla parpadea.
Cuando la electrobomba está en ON, la pantalla parpadea rápidamente (200 mseg ON, 100 mseg OFF).
Cuando la electrobomba está en OFF, la pantalla parpadea lentamente (400 mseg ON, 100 mseg OFF).

9 REAJUSTE GENERAL DEL SISTEMA

Para reencender el equipo sin desconectar la alimentación, pulse los 4 botones simultáneamente.

10 CONFIGURACIONES DE FÁBRICA

Iden ificador	Descripción	Valor configura o
SP	Presión de setpoint	3.0 bares
rt	Sentido de rotación	0
od	Modalidad de funcionamiento	1
rP	Presión para arranque	0.3 bares
tb	Tiempo de bloqueo por falta de agua	10 s
GP	Ganancia del coeficiente proporcional	1.0 para PWM230
GI	Ganancia del coeficiente integral	1.0 para PWM230
FS	Frecuencia máxima de rotación	50
dP	Diferencial de presión con flujos bajos	0 bar
Ft	Umbral de flujo bajo	15
AE	Habilitación de la función anticongelante	1
FP	Frecuencia de prueba en modalidad manual	Igual que el valor FS configurado

10.1 Reajuste de las configuraciones de fábrica

Para reajustar los valores de fábrica, apague el aparato, pulse y mantenga pulsados los botones SET y + mientras se enciende de nuevo el equipo, suelte los dos botones únicamente cuando aparece escrito "EE". En este caso el PWM ejecuta un reajuste de las configuraciones de fábrica (una escritura y una relectura en EEprom de las configuraciones de fábrica guardadas permanentemente en la memoria FLASH). Concluida la configuración de todos los parámetros, el PWM vuelve al funcionamiento normal.

11 CARACTERÍSTICAS TÉCNICAS

Corriente máx. de fase del motor	4,5 A
Tensión de línea	230 Vrms monofásica
Tensión de la electrobomba	230 Vrms trifásica
Peso de la unidad (embalaje excluido)	3,7kg
Posición de trabajo	Cualquiera
Temperatura máxima del líquido	50°
Temperatura máxima de servicio	60°
Presión máx.	10 bares
Rango de regulación de la presión	de 1 a 9 bares
Medidas máximas (L x H x P)	22x28x18 cm
Conexión hidráulica entrada fluido	1 ¼" macho
Conexión hidráulica salida fluido	1 ½" hembra
Grado de protección	IP 55
Protecciones	funcionamiento en seco amperimétrica sobretemperatura de la electrónica

EASY VARIO

Instruction manual

PWM230

PWM400

PWM400/7.5

Ver. 2.3

saci pumps

TABLE OF CONTENTS

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FIGURES INDEX

Conventions used in this manual

In the manual the following symbols will be used:

Generic danger. Failure to comply with the safety regulations that follow can irreparably damage the equipment.

Electric shock risk. Failure to comply with the safety regulations that follow can cause risk to personal safety.

WARNINGS

Read this manual carefully before any operation.
Please keep this instruction manual for future use.

The Electrical and Hydraulic connections must be carried out by competent, skilled personnel in possession of technical qualification required by the specific legislation in force.

The term **skilled personnel** means persons that, because of their training, experience and instruction, as well as their knowledge of the relevant standards, regulations and accident prevention rules and working conditions, have been authorized by the person responsible for safety of the plant to perform all the appropriate activities required, and thereby are able to recognize and prevent potentially dangerous situations.
(For the definition of skilled personnel see IEC 364).

The technician must ensure that the installation of power supply is provided of an efficient earthing system, conforming to the regulations in force in the country where the product is installed.

For installation of the power supply, we recommend to use a high sensitivity residual current device with Δ=30 mA (class A or AS).

To improve immunity to the possible noise radiated on other equipments we recommend to power the PWM with a separate wire.

Failure to comply with the safety regulations not only causes risk to personal safety and damage to the equipment, but also invalidates every right to assistance under warranty.

CE EN 55014-1 (2001/11) CEI EN 55014-2 (1998/10) CE EN 61000-3-2 (2002/04)
CEI EN 61000-3-3 (1997/06) CE EN 60335-1 (2004/04)
Basic Regulation: EN 61000-6-2 (2002/10) Rif: CE EN 61000-4-2 (1996/09)
Rif: CE EN 61000-4-3 (2003/06) Rif: CE EN 61000-4-4 (1996/09)
Rif: CE EN 61000-4-5 (1997/06) Rif: CE EN 61000-4-6 (1997/11)
Rif: CE EN 61000-4-8 (1997-06) Rif: CE EN 61000-4-11 (1997/06)

CE RoHS

RESPONSIBILITY

The manufacturer is not liable for malfunctioning if the product has not correctly been installed, damaged, modified, and/or run outside the recommended work range or in contrast with other indications given in this manual.
The Manufacturer declines all responsibility for possible errors in this instructions manual, if due to misprints or errors in copying.
The Manufacturer reserves the right to make any modifications to products that it may consider necessary or useful, without affecting the essential characteristics.
The responsibility of the manufacturer is limited to the product and excludes costs or greater damages caused by incorrect installations.

1 INTRODUCTION

The PWM system is installed downstream from a pump. Operation of the pump is regulated by the PWM so that a constant water pressure is maintained. Moreover, depending on conditions and usage needs of the hydraulic system, the pump is turned on or off and malfunction conditions are managed.
The end user sets the parameters using the keyboard, and the PWM manages the pump according to the user's needs (to do this, particular algorithms are used to control frequency of rotation). The PWM system turns on the pump when there is a water demand and turns it off when there is no more demand of water.
PWM has many operation modes designed to protect the pump and the hydraulic and electric installations.
PWM has several configurable inputs and outputs and it can adapt to the demands of the various plants.
Section 5.1 describes all configurable quantities (pressure, protections, frequency of rotation, etc) and the possible pressure regulation modes (as a function of flow, inputs, exchange with other PWM, etc).
An important feature that makes the difference between PWM and the common On/Off systems is the considerable energy saving that can exceed 85% in some usage conditions. In Appendix an energetic and economic comparison between direct-insertion and PWM systems is made.
The PWM allows a longer lifetime of the pump.
Noise emitted by the pump managed by a PWM system is generally much lower than that emitted by the same one in direct insertion.

The model PWM 230 drives electro pumps with standard three-phase asynchronous motors (230V configuration) even if a single-phase 230 V line supplies it.
The PWM 400 and PWM 400/7.5 models drive electro pumps with standard three-phase asynchronous motors (400V) and a three-phase line supplies them.

Note: This manual is related to the following products: PWM 230, PWM 400 and PWM 400/7.5; for simplicity sake the term "PWM" will be used when talking about characteristics that are common to all the versions. Otherwise the specific names of the products will be used.

1.1 Applications

PWM systems are useful in all cases we need to control one or more pumps managing their turn-on and turn-off. The PWM system maintains a constant pressure by changing the frequency of rotation of the pump. Normally, the pump takes water from a basin or a well.

Typical usage scenarios include:

- Houses
- Flats
- Holiday houses
- Farms
- Water supply from wells
- Irrigation of greenhouses, gardens, agriculture
- Rain water reuse
- Industrial plants

PWM systems can be connected to the “Da Vinci” controller board to form a system together with up to 4 PWM in the same installation. The controller allows setting the working parameters and controls the whole system, thus widening usage possibilities of the PWM. PWM works with drinking water, domestic water or clean water without solid particles or suspended abrasive material.

PWM cannot be used with: feed liquid, inflammable fluid, by-products of the hydrocarbons, aggressive, corrosive or viscous fluids.

1.2 Technical features

The following chart shows all technical features of the PWM series systems

	PWM 230	**PWM 400**	**PWM 400/7.5**
Max. current	9,3 A	13,3 A	7.5 A
Power supply voltage	230 V single-phase tolerance: +10%; -20%	400 V three-phase tolerance: +10%; -20%	400 V three-phase tolerance: +10%; -20%
Minimum voltage	184 V	320 V	320 V
Maximum voltage	264 V	457 V	457 V
Pump motor type	230 V three-phase	400 V three-phase	400 V three-phase
Unit weight (packing not included)	3,7 Kg.	5,0 Kg.	5,0 Kg.
Installation Position	Any	Vertical	Vertical
Max. fluid temperature	50°C		
Max working temperature	60°C		
Max pressure	16 bar		
Set Pressure range	1 - 15 bar		
Max. Flow	300 l/min		
Dimensions (LxHxD)	22x28x18 cm		
Hydraulic Joint Inlet	1 ¼” male		
Hydraulic Joint Outlet	1 ½” female		
Degree of protection	IP 55		
Connectivity	RS 485 serial interface		
Protections	Dry run Overcurrent Overtemperature Abnormal supply voltage Direct short circuit of output phases		

Table 1: Technical features

For further details about pressure loss of PWM, please see the appendix.

2 INSTALLATION

2.1 Hydraulic connection

Always install a check valve on the pipe between pump and PWM as shown in Figure 1 part n° 12.

The following Picture shows the scheme of a correct Hydraulic installation.

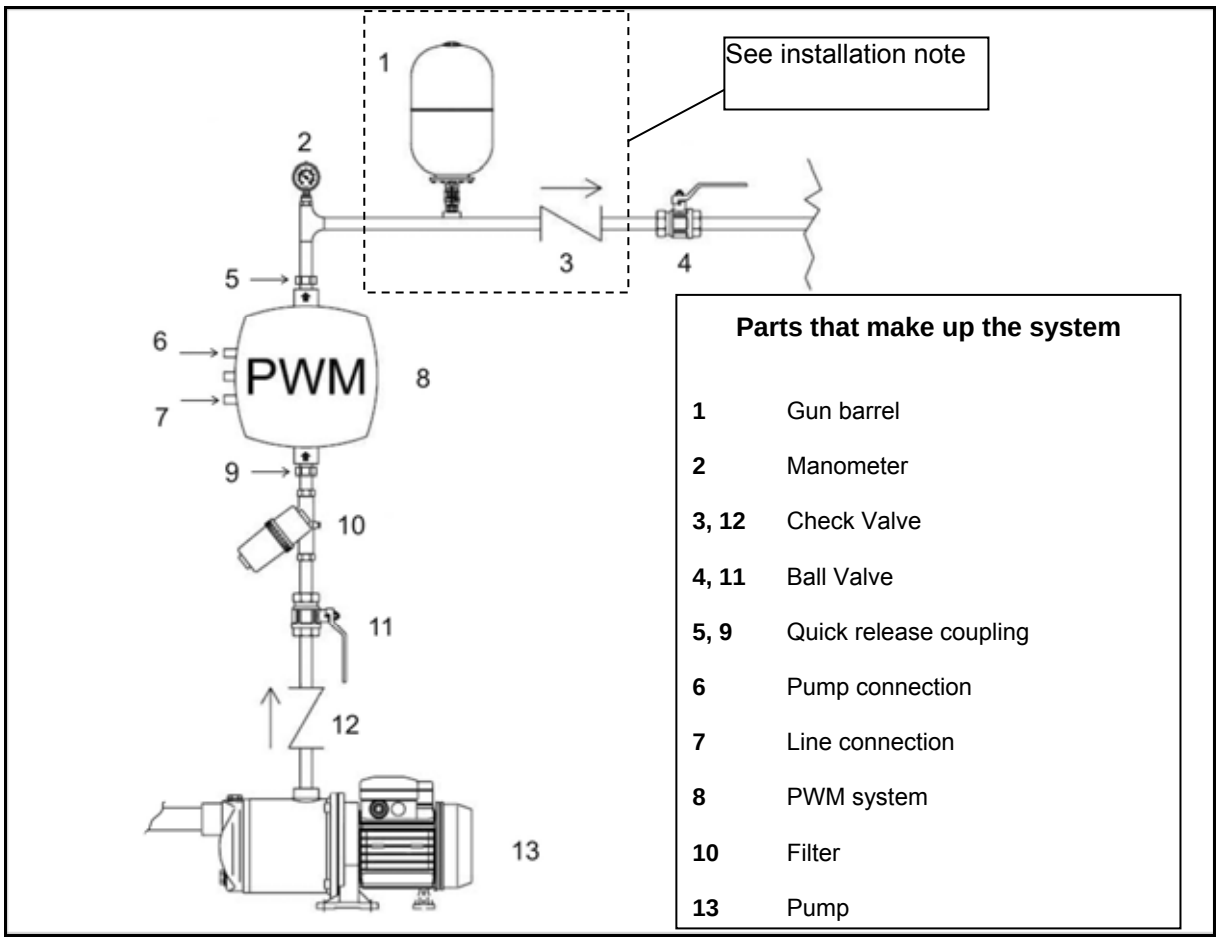


Figure 1: Hydraulic diagram

We recommend installing a little gun barrel downstream from the PWM.

We recommend installing another check valve after PWM and an expansion Tank between the check valve and PWM (see Picture 1 part n°1 and 3), on all Installation on which there's a possibility to have water hammering (e.g. irrigation whose flow is unexpectedly blocked by the check valve). The check valve between pump and PWM mentioned above (12) **is necessary.**

The hydraulic connection between PWM and pump must not have any derivation.
A pipe of adequate size must feed the pump.

The hydraulic connection between pump and PWM should be shorter and more rigid. In fact, when this connection is too long or deformable, oscillations on regulation can happen, which can be solved by modification of the "GP" and "GI" control parameters (see sec. 5.1.3.2 and 5.1.3.3)

Note: The PWM system works at constant pressure. This regulation is appreciable if the hydraulic system downstream from the PWM system is correctly installed. Systems made with too narrow pipes cause pressure losses which the appliance cannot compensate; the result is that the pressure is constant on the PWM device but not on the user.

PWM400 and PWM400/7.5 must be installed only in vertical position, while PWM230 can be installed in any position. Internal pipe where water flows shows horizontal or vertical direction, while the arrows on the same pipe show flow direction.

Ice/Frost danger: Pay attention to the environmental conditions where the PWM will be installed and to the electrical connection in the cold months. Two types of usage precautions should be observed in case that environment temperature drops below 0°c.
- If PWM is working it is absolutely necessary to protect it adequately from the cold and to keep it constantly fed.
- If PWM is not working it should be disconnected both from power supply and from the pipes and any water inside it should be removed. To ease this procedure a quick release coupling is advisable.
Please note that removing pressure from the pipeline is not enough, since after doing that some water still remains inside the PWM.

Note: If PWM is disconnected from power supply, the anti-freeze protection does not operate (see sec. 5.1.3.8).

Foreign bodies in the pipeline: the presence of dirt inside the fluid can obstruct the duct or stop the flow valve, thus jeopardizing correct operation of the system. In case that the PWM is installed on a pipeline through which foreign bodies (e.g. gravel in case of submersibles pumps) can transit, it is necessary to install a special filter upstream from the PWM. A coarse porosity one (100 μm) will be suitable as well.

2.2 Electrical connection PWM 230

Power supply to the PWM 230 should meet the following requirements:

Rated voltage	230 V (+ 10% / - 20%)
Minimum absolute voltage	184 V (230 V - 20%)
Maximum absolute voltage	264 V (240 V + 10%)
Frequency	50 / 60 Hz

Table 2: PWM 230 power supply requirements

DANGER Electric shock risk
Before carrying out any installation or maintenance operation, the PWM should be disconnected from the power supply and one should wait at least 2 minutes before opening the appliance.

Ensure that rated voltage and the frequency values of the PWM match those of the Power supply.

WARNING
Power supply voltage can change when the pump is turned on by the PWM device.
The power line voltage can change, due to connection of other devices and to the quality of the power line self.

2.2.1 Connection to the PWM 230 power supply line

Normally PWM devices are equipped with a power cord to connect the device to a 220V-240V single-phase electric line, but some versions are not. In those versions the electric line must be connected to the 3 ways terminal “J2” with “LINE” silk-screened on it (see Figure 2).

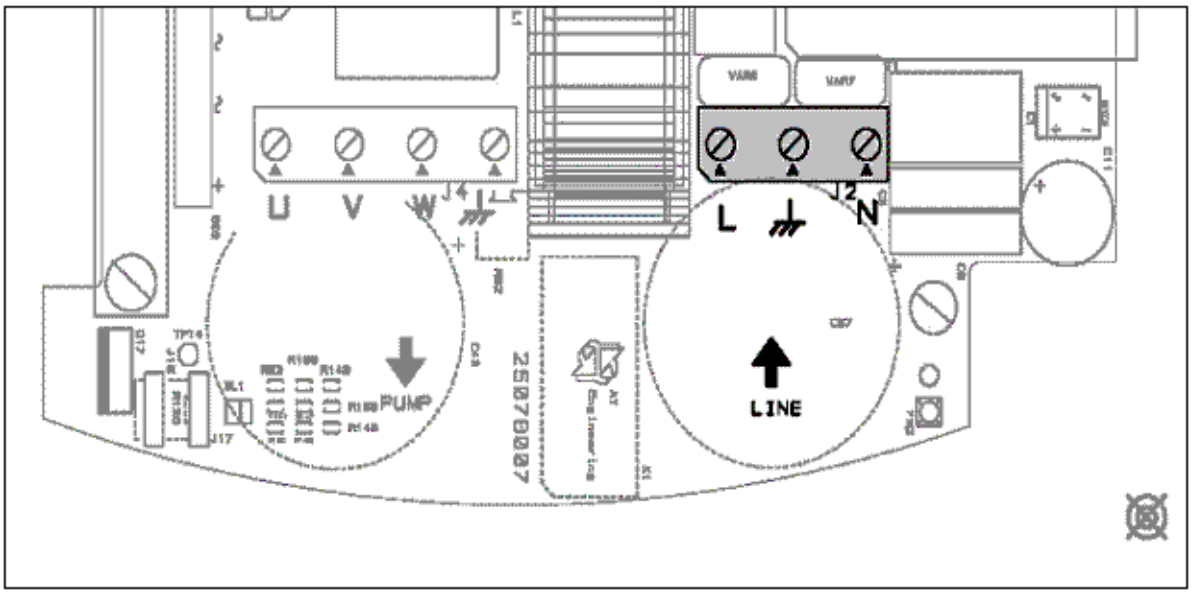


Figure 2: Power supply terminal

If the installed electro pump's power equals the PWM's maximum allowed one, the power cord wires' section should be greater than a given value, depending on the cord's length. Table 3 shows the minimum wires' section as a function of the cord's length.

Length (meters)	Minimum section (mm^2)
0 – 30	2.5
30 – 60	4

Table 3: Minimum section as a function of power cord's length for PWM 230

If the installed pump's power is lower than the maximum allowed one, the power cord wires' section can be reduced proportionally to the power decrease (for example if the total power halves, the section will be halved).
PWM 230 already provides internal current protections. If a thermal magnetic circuit breaker is installed, its rated current must be 16 A.

Connection of the power line to PWM 230 must include a ground wire whose impedance must comply with the safety regulation in force in the country of use. The total grounding resistance must not exceed 100 Ohm.

2.2.2 Electrical connection to the electro pump for PWM 230 device

The supply voltage of the motor of the installed electro pump must be 230V three-phase.
The current absorbed by the pump connected to PWM230 must not exceed 9,3A rms.

The three-phase motors with rated supply voltages that differ from 230V, cannot work with PWM 230. Check the motor connection rating values to fulfil the condition above.
Three-phase electric machines generally have two types of connection as shown in Figure 3 and Figure 4.
The delta connection is typically the one used to work at 230V (see Figure 4).

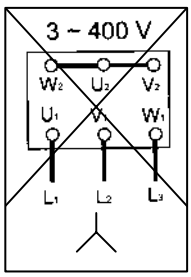


Figure 3: Wrong connection

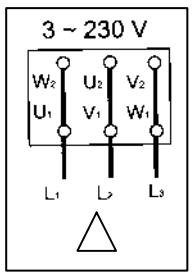


Figure 4: Right connection

Normally PWM devices are equipped with a cable for connection to the motor. The connection between PWM 230 and the electro pump is made with a 4-wire cable (3 phases + ground).
For versions not equipped with the cable mentioned above the connection is made on the 4-ways terminal "J4" with "PUMP" silk-screened on it and an arrow at the output (see Figure 5). The section of the wire must be at least 1.5 mm^2 for any length.

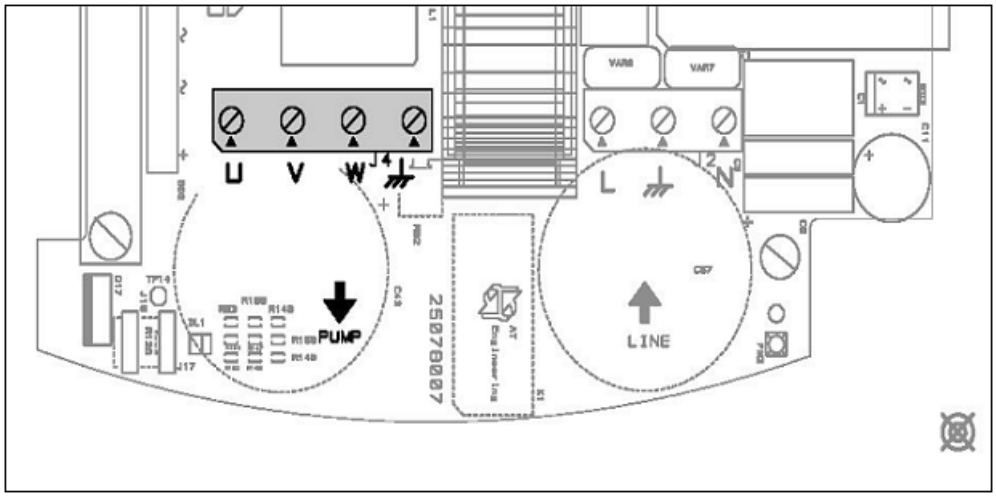


Figure 5: Three-phase electro pump output terminal

Wrong connection of the earth line to a terminal other than the earth one may cause irremediable damage to the whole appliance.

Wrong connection of the power supply line on output terminals intended for the load may cause irremediable damage to the whole appliance.

Once the electric and hydraulic connections are completed, turn on the system and configure it, as described in chapter 4.

2.3 Electrical connection of PWM 400 and PWM 400/7.5

Power supply to the PWM 400 and PWM 400/7.5 devices should meet the following requirements:

Rated voltage	400 V (+ 10% / - 20%)
Minimum absolute voltage	320 V (400 V - 20%)
Maximum absolute voltage	457 V (415 V + 10%)
Frequency	50 / 60 Hz

Table 4: PWM 400 power supply requirements

DANGER Electric shock risk
Before carrying out any installation or maintenance operation, always disconnect the PWM from the power supply and wait at least 2 minutes before opening the appliance.

WARNING
Ensure that the voltage and frequency values of the PWM rating plate match those of the Power supply.

WARNING
Power supply voltage can change when the PWM device turns on the pump.
Power line voltage can change, due to connection of other devices and to quality of the line self.

2.3.1 Connection of the PWM 400 – PWM400/7.5 to the power supply line

Normally PWM devices are equipped with a power cord labelled “Line” to connect to a 380V-415V 50-60Hz three-phase electric line. For versions that are not, the line must be connected to the 4-ways terminal “J2-J8” with “LINE” silk-screened on it (see Figure 6).

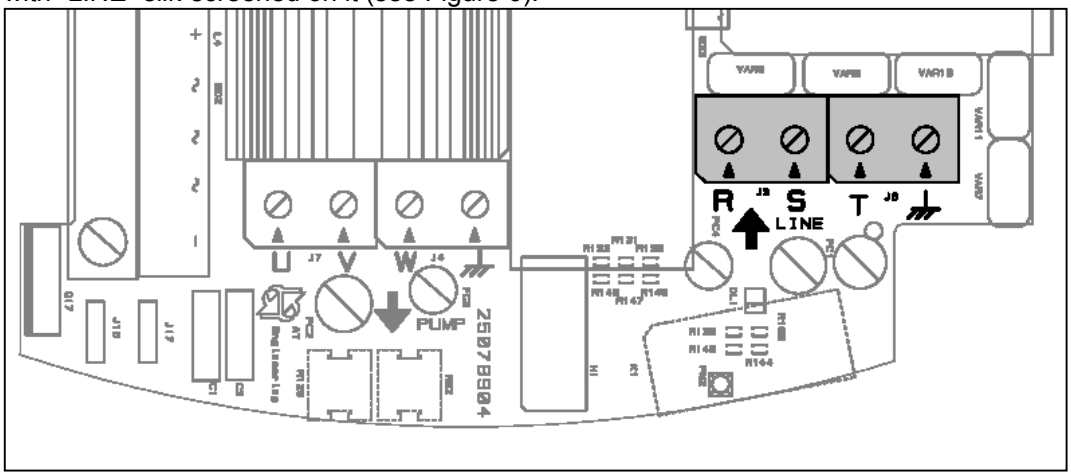


Figure 6: Power supply line input terminals

If the installed electro pump’s power equals the maximum allowed one, the power cord wires’ section should be greater than a given value, depending on the cord’s length. Table 5 shows the minimum wires’ section as a function of the cord’s length.

Length of the line (meters)	Min. section of every conductor (mm^2)
0 - 50	1.5
50 - 85	2.5
85 - 140	4

Table 5: Minimum section as a function of power cord’s length for PWM 400

If the installed pump’s power is lower than the maximum allowed one, the power cord’s wire section can be reduced proportionally to the power decrease (for example if the total power halves, the section will be halved).

PWM 400 and PWM400/7.5 already provide internal current protections. If a thermal magnetic circuit breaker is installed, its rated current must be 16 A.

Connection of the power line to PWM must include a ground wire whose impedance, must comply with the safety regulation in force in the country of use. The total grounding resistance must not exceed 100 Ohm.

2.3.2 Electrical connection of the electro pump to PWM 400 – PWM400/7.5 devices

The supply voltage of the motor of the installed electro pump must be 400V three-phase.
Phase current absorbed by the utility connected to PWM400 must not exceed 13A rms and 7.5A rms for PWM 400/7.5.
Three-phase motors whose rated voltage differs from 400V cannot be operated with PWM 400 and PWM 400/7.5.
Check the motor connection ratings to fulfil the above condition.
Typically, when line voltage is 400V, if the pump’s power is lower than 5.5 kW, a star wiring is used.
Conversely, if the pump’s power exceeds 5.5 kW, a delta wiring is used.
Figure 7 shows how to make the proper connections.

Typical connection for devices with power lower than 5,5 kW	Typical connection for devices with power greater or equal to 5,5 kW

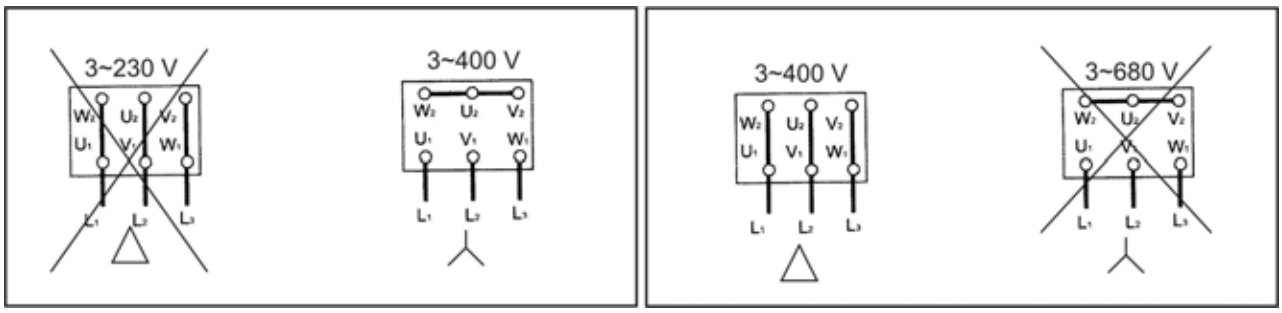


Figure 7: Connection to be made on a motor managed by PWM 400

Normally the PWM devices are equipped with a cable labelled “Pump”, for connection to the motor. Connection between PWM 400 – PWM400/7.5 and the electro pump is made with a 4-wire cable (3 phase + ground) and is made on the 4 ways terminal "J7-J4" with “PUMP” silk-screened on it and an arrow at the output (see Figure 8). The section of the wire must be greater or equal to 1.5 mm^2 for any length.

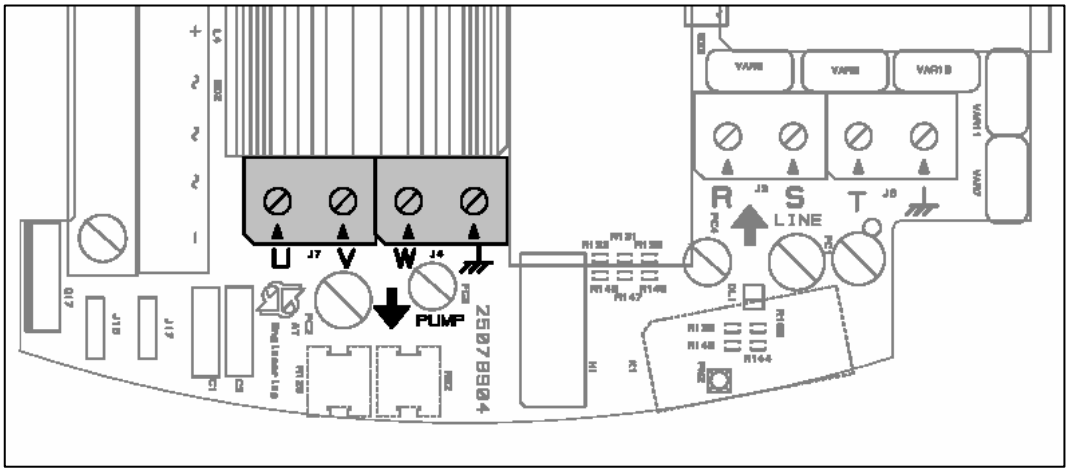


Figure 8: Three-phase electro pump output terminal

Wrong connection of the earth line to a terminal other than the earth one may cause irremediable damage to the whole appliance.

Wrong connection of the power supply line on output terminals intended for the load may cause irremediable damage to the whole appliance.

Once the electric and hydraulic connections are completed, turn on the system and perform the operations described in chapter 4.

2.4 Electrical connection of user inputs and outputs of PWM230 PWM400 PWM400/7.5

All PWMs are equipped with 3 inputs and 2 outputs used to connect to other devices.
Figure 9 and Figure 11 show the logical-functional schemes of possible connections.
Figure 10 and Figure 12 show, as an example, two possible inputs and outputs configurations.
The installer will just need to connect the desired input and output contacts as desired and to configure related functionality (see section 5.1.3.9).

The +12Vdc voltage supplied to the pin 1 and 7 of J22 can supply max. 50mA.

Output contacts features:
- Relay switch OUT 1: Pin 8 and 9. Relay switch OUT 2: Pin 10 and 11.
- Potential-free contact ratings: 250 Vac, 6 A max resistive load, 3 A max inductive load.

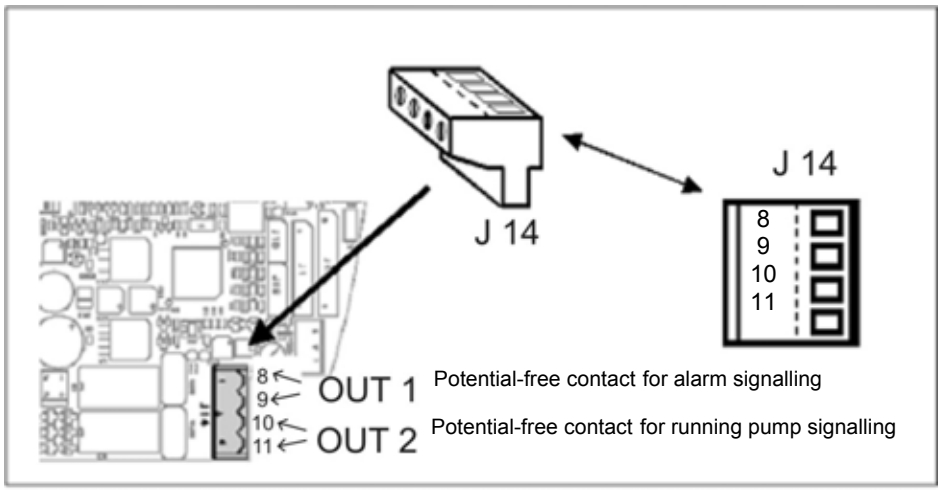
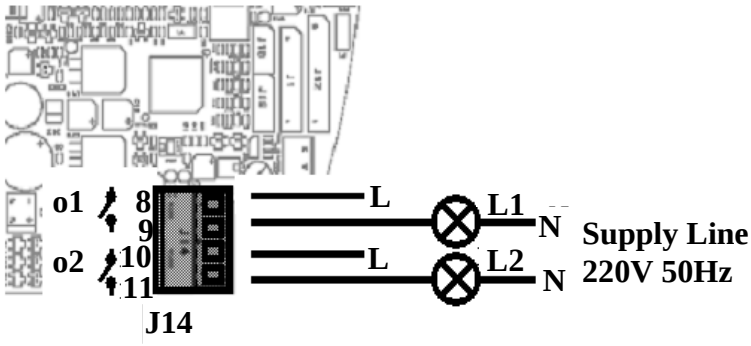


Figure 9: User output terminal

Example application of o1 and o2 outputs



Relay switch o1: Pin 8 and 9.

Relay switch o2: Pin 10 and 11

250Vac potential-free contact - 6A max with resistive load.

- 3A Max with inductive load.

With the factory settings (o1 = 2: NO contact; o2 = 2: NO contact), L1 is on when there is fault (ex. "bL": blockage due to lack of water). L2 is on when the pump is running ("Go").

Figure 10: Example application of user outputs

Optocoupled input contacts' electrical features:

- Opto coupler IN 1: Pin 5 and 6.
- Opto coupler IN 2: Pin 2 and 4.
- Opto coupler IN 3: Pin 3 and 4.
- Inputs can be driven with any polarity with respect to their own earth return and they work with alternate or direct current.
- Correct operation is guaranteed if input voltages comply with the following requirements:

	Input DC [V]	Input AC [V rms]
Trigger voltage	8	6
Max turn-off voltage	2	1,5
Max. rated voltage	48	50

Table 6: Optocoupled input contacts ratings

When input voltage is 12VDC input current is 3mA.

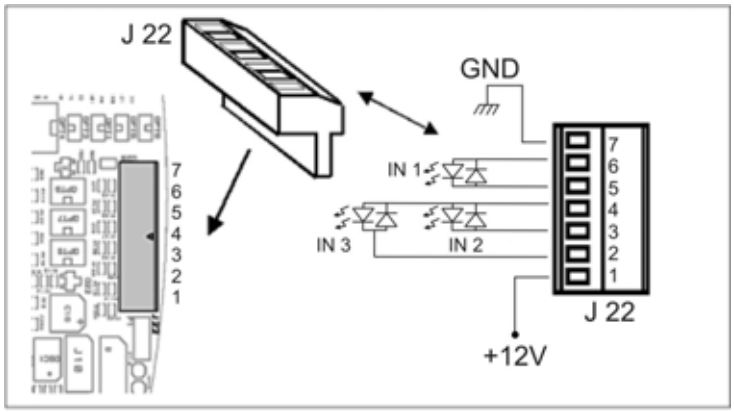


Figure 11: User input terminal

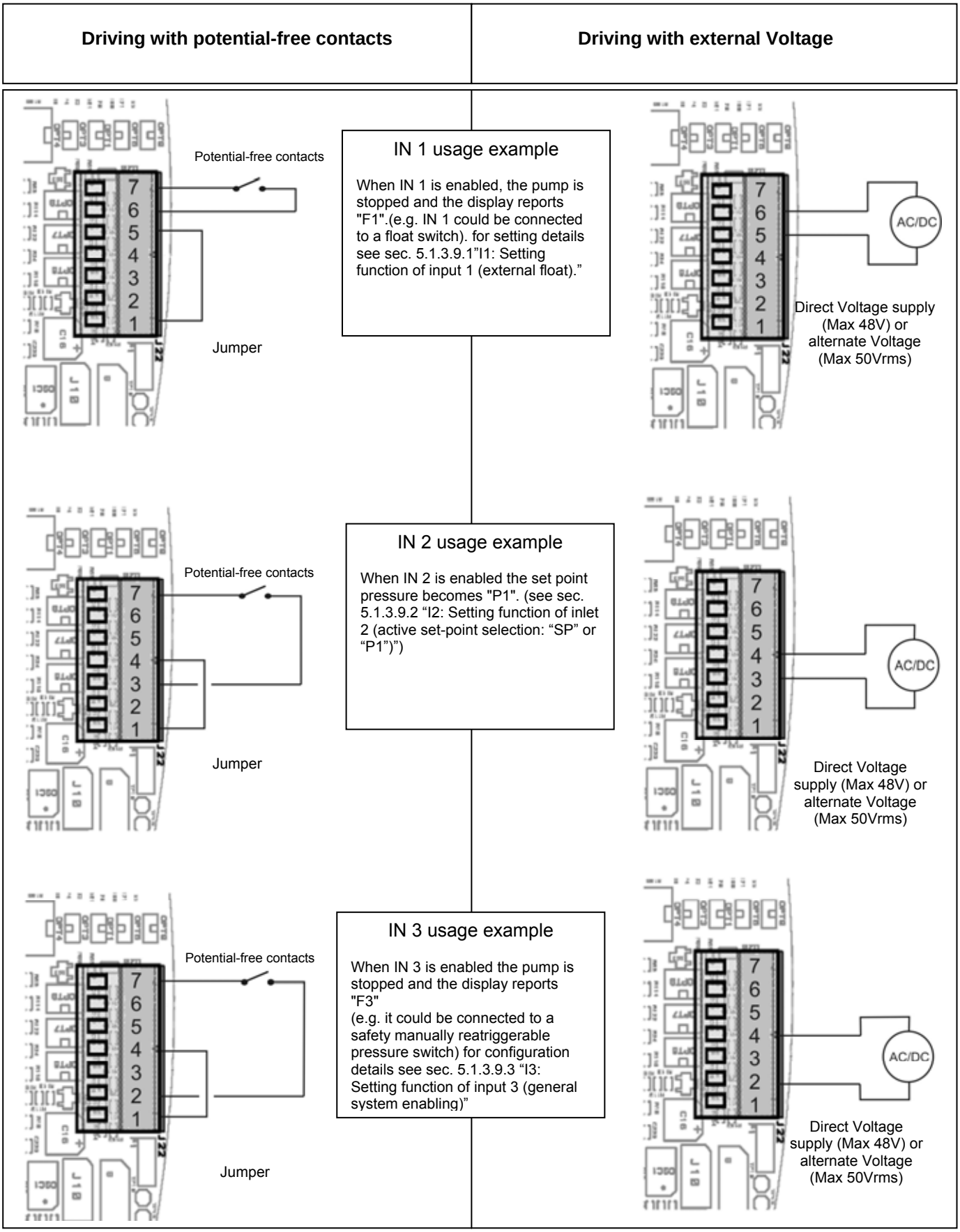


Figure 12: User inputs usage example

2.5 Electrical connections for interconnection and exchange

Each PWM has a communication port through which it can be connected by means of a special cable, to another PWM or to a compatible controller board.

WARNING: When interconnection cable's length exceeds 1m, usage of a shielded cable with braid connected to earth (central pin number 2) is recommended on both devices.

2.5.1 Electric wiring for interconnection of two PWM

Two PWM devices may operate in a synchronized way (see sec. 5.1.2.6 "Ad: Setting the interconnection address", 5.1.2.6.1 "Setting the address for booster sets composed by 2 PWM", 5.1.2.7 "Eb: Enable booster" and 5.1.3.7 "CM: Role exchange policy in booster sets").

To use this functionality, two devices must be wired with a three-pole cable trough the terminal block J9, as illustrated on Figure 13.

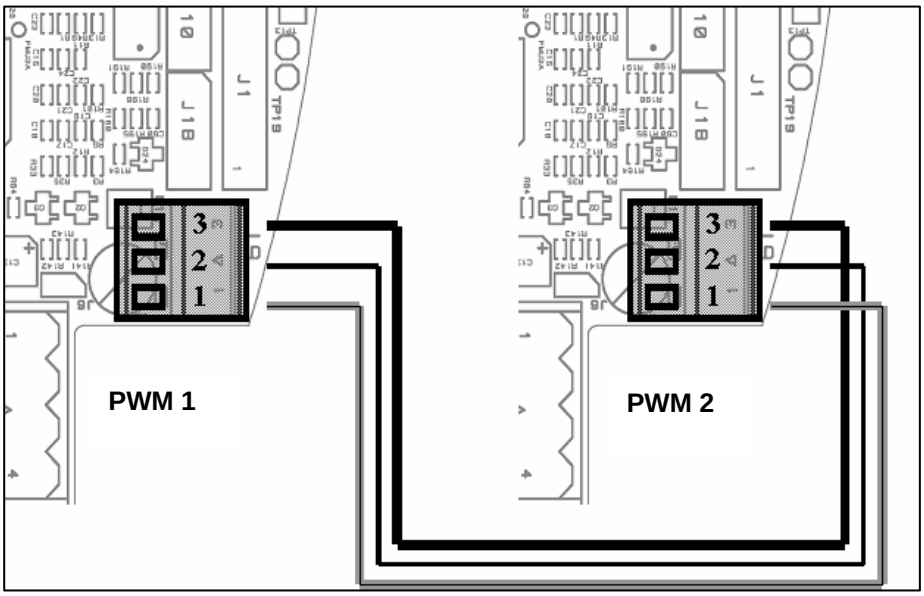


Figure 13: Wiring diagram for two PWM in exchange

2.5.2 Electrical connections for wiring with "Da Vinci" controller board

One or more PWMs can be wired to the "Da Vinci" controller board that monitors the system, controls and manages the PWM's operation (see instruction manual of "Da Vinci" controller board).

Two devices are wired by means of a three-pole cable trough the terminal block J9 as illustrated on Figure 14.

The three PWM Terminals are wired to the controller board as shown on Table 7.

PWM 1 Connection		PWM 2 Connection		PWM 3 Connection		PWM 4 Connection	
PWM terminal	Controller board terminal	PWM terminal	Controller board terminal	PWM terminal	Controller board terminal	PWM terminal	Controller board terminal
1	B1 -	1	B2 -	1	B3 -	1	B4 -
2	SH	2	SH	2	SH	2	SH
3	B1 +	3	B2 +	3	B3 +	3	B4 +

Table 7: Pin out of cable used for communication between PWM and "Da Vinci" controller board

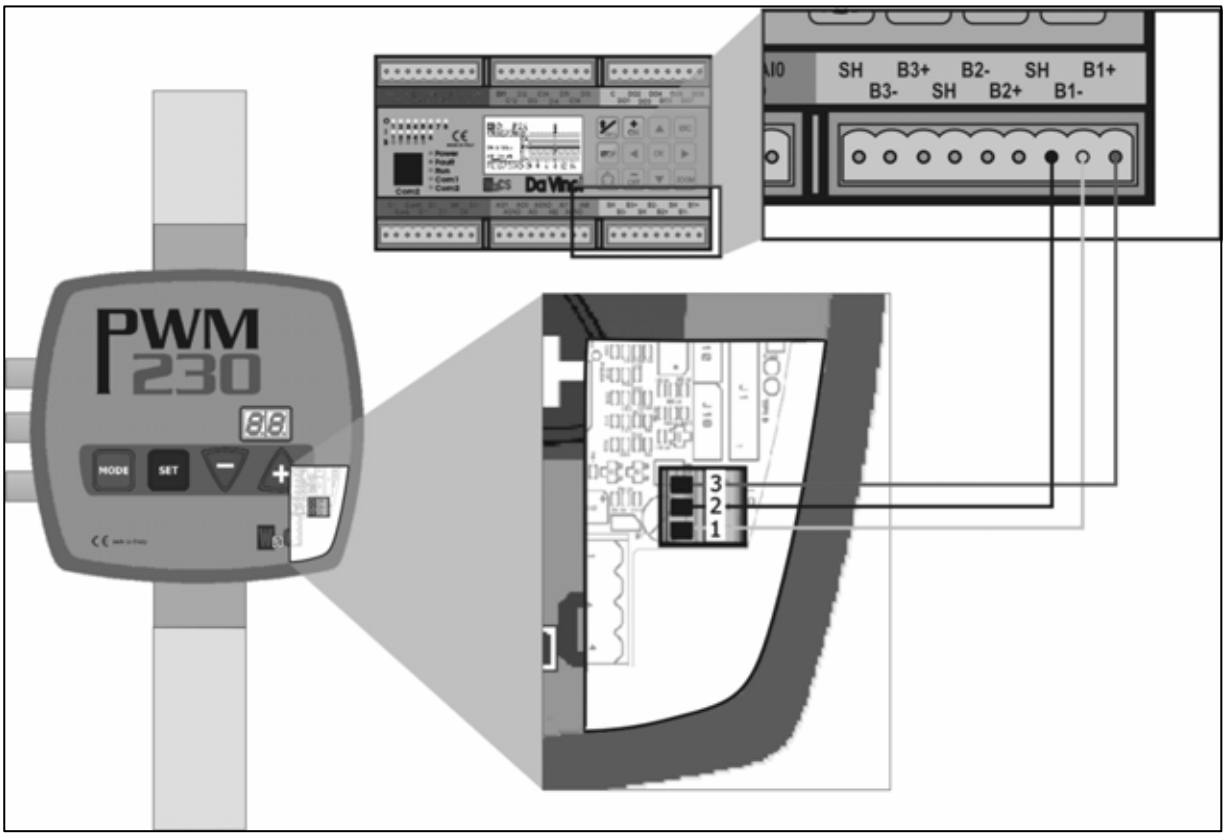


Figure 14: Wiring diagram for connection of PWM to the "Da Vinci" controller board.

Note: For PWM systems wired and configured to work with "Da Vinci" controller board operation of input 2 is disabled (see sec. 5.1.3.9.2), a new menu called "AS" is activated (see sec. 5.2.1.4) and the "rP" parameter becomes unavailable (see sec. 5.1.2.5).

3 THE KEYPAD AND THE DISPLAY

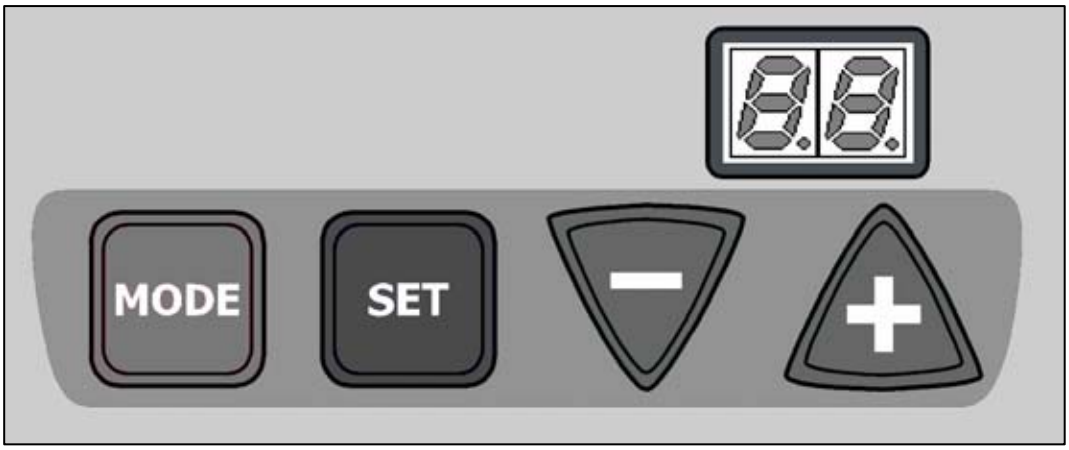


Figure 15: PWM's Keypad and Display.

The PWM front panel is equipped with a control keypad with 4 keys and a two-digit display used to show quantities, numerical values and possible block and protection conditions.

3.1 Keys functionality

	MODE is used to pass to the next item of the current menu
	SET is used to quit current menu and to go back to normal display mode
	Press it to decrease the currently modifiable parameter. Each time you press it, the quantity value is displayed for at least 5 seconds. Thereafter the parameter name appears.
	Press it to increase the currently modifiable parameter. Each time you press it, the quantity value is displayed for at least 5 seconds. Thereafter the parameter name appears.

Note: When "+" or "-" is pressed, the selected quantity will be changed and immediately saved in permanent memory (EEPROM). Hence, the parameter value won't be lost if the device is (even accidentally) turned off.  is just used to return displaying the machine status. It is not necessary to press SET to save the last parameter changes.

3.2 Display conventions

Parameters are identified by an alphanumeric name and by a value. The meaning of parameter names is summarized on Table 8. When a message (e.g., an error) is shown two static characters appear. Conversely, a parameter is shown by alternatively displaying its name (for 1 second) and its value (for 5 seconds).
In order to simplify configuration, only the value is shown as long as either the "+" key or the "-" key is pressed.
Some values need 3 digits to be displayed, e.g. frequency or temperature. In this case the display convention is the following:

The name of the parameter appears at first for a second. Thereafter the hundreds are shown and, finally, the tens and the units are shown. The Hundreds are represented on the right digit, while the left one is off; thereafter the left digit represents the tens while the right digit represents the units. Three-digit numbers are completely displayed for three times in 5 seconds, and then the two-letters parameter name will be displayed for one second. During value modification only tens and units of three-digit parameter values are shown. After value modification has completed, parameter values are displayed on three digits again.
For quantities that contain a decimal digit the digit is displayed for values up to 9,9, while when this value is exceeded only tens and units are displayed.

WARNING: When the PWM is configured for connection to another PWM or to a "Da Vinci" controller board (see sections 5.1.2.6, 5.1.2.6.1 and 5.1.2.6.2) but the communication doesn't work, the display blinks when the "Go" or "Sb" status codes are displayed.

3.3 Meaning of the messages shown on the display

Identifier	Description
Indication on the display in normal operation	
Go	Electro pump operating
Sb	Electro pump not operating
Error and Status conditions	
bL	Blockage due to lack of water
bP	Blockage due to missing pressure sensor
LP	Blockage due to low supply voltage
HP	Blockage due to high supply voltage
EC	Blockage due to incorrect setting of the rated current (rC) or rated frequency (Fn)
oC	Blockage due to current overload in the electro pump motor
oF	Blockage due to current overload in the output stages
SC	Blockage due to direct short circuit between the phases of the output terminal
ot	Blockage due to overheating of the power stages
F1	Input 1: Status / Alarm
F3	Input 3: Status / Alarm
E0...E7	Internal error 0...7
Display of the main values (MODE key)	
Fr	Display of the current rotation frequency [in Hz]
UP	Display of pressure [in bar] (duplicated in manual mode)
C1	Display of phase current of the electro pump [in A] (duplicated in manual mode)
AS	Display of PWM configuration status with “Da Vinci” controller board
UE	Display of the software version with which the appliance is equipped

User displays and settings (MODE & SET keys for 2 seconds)	
SP	Setting the set-point pressure [in bar]
Installer displays and settings (MODE & SET & − keys for 5 seconds)	
rC	Setting the rated current of the electro pump [A]
Fn	Setting the rated frequency of rotation of the electro pump [Hz]
rt	Setting the direction of rotation (duplicated in manual mode)
od	Setting the PWM operating mode
rP	Setting the pressure drop for restarting [bar]
Ad	Setting the interconnection address (necessary on booster set with more than one pump with exchange)
Eb	Enabling the booster pump
Technical assistance displays and settings (keys MODE & SET & + 5 seconds)	

tb	Setting of lack of water blockage latency time [s]
GP	Setting of proportional gain of the PI
GI	Setting of integral gain of the PI
FS	Setting of the max. rotation frequency of the electro pump [Hz]
FL	Setting of the min. rotation frequency of the electro pump [Hz]
Ft	Setting of low flow rate threshold
CM	Setting of role exchange policy on booster set with 2 pumps
AE	Setting of enabling of anti-block/anti-frost function
i 1	Setting of input 1 function
i 2	Setting of input 2 function
i 3	Setting of input 3 function
P1	Setting of auxiliary set point pressure [bar]
O 1	Setting of output 1 function
O 2	Setting of output 2 function
DISPLAY (keys SET & − for 2 sec.)	
UF	Display of the flow (duplicated in manual mode)
ZF	Display of zero flow (duplicated in manual mode)
FM	Display of the max. rotation frequency [Hz]
tE	Display of the power output stages temperature [°C]
bt	Display of the printed circuit's temperature [°C]
GS	Display of running status
FF	Display of fault and block history queue
Access to manual mode (keys SET & − & + 5 seconds)	
FP	Setting of manual mode test frequency (in Hz). Must be ≤ to the current FS value
UP	Display of pressure [bar]
C1	Display of the electro pump's phase current [A]
rt	Setting of direction of rotation
UF	Display of flow
ZF	Display of zero flow
Restoring the factory settings (keys SET & + for 2 sec when turning on)	
EE	Saving and reading back of factory settings on the EEPROM
System reset (keys MODE & SET & − & +)	
ZF	General reset (ZF appears when leaving reset and the system is restarted)

Table 8: Meaning of the messages shown on the display

4 START AND FIRST OPERATION

4.1 Start up operation

After a craftsmanlike installation of the hydraulic and electric systems (see sec. 2.1 and 2.2), we can turn on the PWM.
"ZF" will appear on the display and after a few seconds the error code "EC" will be displayed. The PWM doesn't start, since it is necessary to set the value of rated current (in A) and frequency (in Hz) of the electrical pump being used.
The procedures needed to set the main parameters and to perform the first start-up are described below.

a) Setting the rated current.

From the state of normal operation, simultaneously hold the 

keys pressed until "rC" is displayed. Use the  and  keys to set the rated current of the motor in Ampere (A).

Generally the absorbed current value (in A) in the different usage configurations (delta / star) is indicated on the pump's rating plate.
For PWM 230, the motor must be configured to operate with a 230V three phases system (normally with a star wiring). The current to set refers to 230V operation.
For PWM 400 and PWM 400/7.5 the motor must be configured to operate with a 400V three-phase system (normally with a star wiring if power is less than 5,5 KW, with a delta wiring for higher power). The rated current parameter to set refers to 400V operation.

Note: **If the set parameter is lower than the correct one, the "oC" error code will be displayed as soon as current will exceed the set current for enough time.**
If the set parameter is higher than the correct one, the amperometric protection will be activated when current is already beyond the motor's safety threshold.

 **Wrong configuration of an electrical pump motor (star or delta) may irreparably damage the motor.**

Warning: If 

is pressed before setting "Fn", the rated current value is set, but the PWM remains in the blocked state, because the frequency has not been set yet (see point b) and "EC" is displayed until the rated frequency is set.

b) Setting the rated frequency Fn

From "rC" parameter mentioned above, press the 

key once. The pump's rated frequency Fn is displayed.

Set the frequency "Fn" with by pressing the  and  keys until the selected value matches the electro pump's rated one (e.g.: 50Hz).

A further pressure of 

or 

activates the set values of current and frequency and PWM unblocks (provided that no errors or lock conditions are present).

Wrong setting of the electro pump's rated frequency may irreparably damage the electro pump.

c) <u>Setting the direction of rotation.</u>

From "Fn" parameter, press the MODE key once. The current and frequency settings are activated and the current parameter becomes "rt"; the PWM is now operating.
Open a user to make the pump start rotating. Check direction of rotation of the electro pump.
If the direction is correct, you may proceed setting the set-point pressure (point d), otherwise reverse the direction of rotation of the motor with the + and − keys (this function is active also when the motor is turned on). An arrow on the electro pump's motor case is generally used to indicate direction of rotation.
When it is not possible to directly observe the direction rotation of the motor, this can be found by one of the following methods:

<u>Maximum head method</u>

- Press the SET key in order to get to the normal display menu ("Go" or "Sb" is displayed, provided that no errors or lock conditions are present).
- Enter manual mode menu by holding the SET − + keys simultaneously pressed until "MA" appears on display (see chap. 7).
- Start-up the pump by pressing MODE − + at the same time for 2 seconds and take note of the pressure. (if no manometer is available, you may display the "UP" parameter value by pressing the MODE key multiple times)
- Revert the running rotation by holding SET and − pressed for 2 seconds and take note of the pressure again.

The direction of rotation that allows obtaining a higher pressure is the right one.

- Press SET to stop rotation and press it a second time to exit from manual mode menu.

<u>Rotation frequency "Fr" observation method</u>

- Press the SET key in order to get to the normal display menu ("Go" or "Sb" is displayed, provided that no errors or lock conditions are present).
- Open a user and take note of the frequency (press the MODE key, so that "Fr" and the frequency value are displayed alternatively).
- Change the "rt" parameter (as described above) without changing the drawing and take note of the frequency Fr again.
  The rt value that corresponding to the lower rotation frequency (Fr) is the right one.

d) Setting the set-point pressure.

From normal operation status keep the MODE and SET keys both pressed until “SP” appears on the display. In these conditions the + and − keys allow to increase or decrease the desired pressure value.
Set-point pressure may range from 1,0 to 15 bar.

Press SET to go back to normal operation status.

4.2 Typical installation

4.2.1 Installation with an electro pump

Power the PWM and follow the procedures explained in sec. 4.1 (see also Figure 1)

4.2.2 Installation with two electro pumps

- Connect two PWMs with the provided cable using the J9 connector (see sec. 2.5.1).
- Power the PWM
- Follow steps a), b), c), of sec. 4.1with each device (rC, Fn, rt)
- On one of the two devices press MODE SET − for 5 seconds, then press the MODE key multiple times until “Ad” is displayed and with the + and − keys set Ad = 1
- On the other PWM set Ad = 2, as done above with the first PWM
- Set the set-point pressure only on one of the two PWM’s as described in point d) of sec. 4.1.

4.2.3 Installation with 1, 2, 3 or 4 electro pumps and “Da Vinci” controller board

- Connect the PWM with the provided cable to the “Da Vinci” controller board (see sec. 2.5.2).
- Power the PWM and the controller board
- Follow steps a), b), c), of sec. 4.1 with each PWM (rC, Fn, rt)
- On each PWM press MODE SET − for 5 seconds, press the MODE key multiple times until “Ad” is displayed and with the + and − keys set Ad = 3
- Set the set-point pressure from the controller board (see “Da Vinci” user instr. Manual)

4.3 First installation troubleshooting

PWM message	Possible causes	Solution
EC	Current (rC) or frequency (Fn) of the pump not set	Set “rC” parameter (see sec. 4.1) Set “Fn” parameter (see sec. 4.1)
bL	1) Lack of water 2) Pump unprimed 3) Reverse rotation direction	1-2) Prime the pump and check there is no air in the pipeline. Check that suction pipe and filters are not occluded. Check that the pipeline from the pump to PWM is not broken and has no serious leakages. 3) Check the direction of rotation (see sec. 5.1.2.3)
OF	1) Excessive current absorption 2) Pump blocked	1) Check the connection type, delta or star. Check that the current absorbed by the motor does not exceed the maximum current the PWM can deliver 2) Check that no foreign body is opposing to the impeller or the motor’s motion. Check the phases' connection of the motor.
OC	1) Wrong setting of the pump current (rC). 2) Pump blocked	1) Set rC with the current related to the type of wiring (star or delta) written on the rating plate (see sec. 4.1). 2) Check that no foreign body is opposing to the impeller or the motor’s motion. Check the phases' connection of the motor.
E1 or **LP**	1) Low supply voltage 2) Excessive voltage drop on the line	1) Check the power supply voltage. 2) Check the power cord wires’ section (see sec. 2.2 and 2.3)
Blinking Sb or **Go** (Applies when two PWM or PWM and the “Da Vinci” controller board are connected)	Communication failure	Check the correct Parameter setting Ad (see sec. 5.1.2.6) Check the communication cable’s integrity and proper connection. Check the communication cable’s pin out (see sec. 2.5)
bP	Disconnected pressure sensor	Check the pressure sensor is properly connected
SC	Short circuit between the phases	Ensure the motor is properly working and check its connections to PWM

5 PARAMETER MEANINGS

5.1 Configurable parameters

5.1.1 User's parameters (MODE & SET access keys)

WARNING: If during this phase an error or a malfunctioning occurs, the display will not be modified. Depending on the kind of error, the electro pump can be stopped. Nevertheless, it is still possible to make the desired calibration. In order to know which kind of error occurred, you must go back to the mode where you can see the operation status by pushing the SET button.

5.1.1.1 SP: Setting the set-point pressure

From normal operation status keep the "MODE" and "SET" keys simultaneously pressed until "SP" appears on the display. In these conditions the + and - keys allow to increase or decrease the desired pressure.
Set-point pressure may range from 1,0 to 15,0bar.
Press "SET" to go back to normal operation status.

Note: when the system is configured to work with the controller board (see sec. 5.1.2.6) SP cannot be set from PWM menu, because regulation is managed by the controller board. If communication is lost, PWM automatically loads as SP the last restart pressure value sent to it by the controller board.

The PWM restart pressure is set through the "rP" parameter that represents the pressure decrease (measured in bar), with respect to "SP", that causes the pump to start (see sec. 5.1.2.5)

Example: SP = 3,0 bar; rP = 0,5 bar:
During normal operation the system will be pressurized at 3,0 bar.
The electro pump will restart, when pressure goes under 2,5 bar.

Note: The rP parameter is not available in case of controller board controlled operation (see sec. 5.1.2.6.2)

5.1.2 Installer's parameters (access keys MODE & SET & -)

Warning: If an error of malfunctioning occurs during this phase, the display is not changed. Depending on the type of error, the electro pump may turn off. However, it is still possible to make the desired calibration. To know which type of error occurred you must press the SET key in order to return to the mode in which the operating status is displayed.

From normal operating status, hold down the "MODE" & "SET" & "-" (minus) keys simultaneously pressed, until "rC" appears on the display. In these conditions the + and - keys allow you to increase and decrease the value of the parameter respectively, while the MODE key allows you to move to the next parameter in cyclic mode.
Press SET to return to normal operating status.

5.1.2.1 rC: Setting the rated current of the electro pump

Generally on the electro pump motor there is a rating plate showing the absorbed current value (in A) of the different configurations of the same motor.

For PWM 230 the motor must be configured to work with a three-phase 230V (usually delta-wired) set of voltages. The current to be set refers to 230V operation.

For PWM 400 and PWM 400/7.5 the motor must be configured to work with a three-phase set of voltages of 400V rms in amplitude.
Typically, for electro pumps absorbing up to 5,5 KW a star wiring is used, whereas for higher power a delta wiring is used (the indications shown on the rating plate or on electro pump terminal board should always be followed, anyway).
The current to be set refers to 400V operation.

If the set value is lower than the correct one, during operation the "oC" error will be displayed as soon as current will exceed the set value for enough time.
If the set parameter is higher than the correct one, the amperometric protection will be activated when current is already beyond the motor's safety threshold.

An electrical motor driven by PWM 230 and wrongly used with a star configuration or driven by PWM 400 or PWM 400/7.5 and wrongly used with a delta configuration may be seriously damaged.

5.1.2.2 Fn: Setting the rated frequency

This Parameter represents the rated frequency of the electro pump and can range from 50Hz to 130 Hz (default is "--", i.e. not set).
By pressing the "+" or "-" keys a frequency of 50Hz or 60 Hz can be selected. Holding these keys pressed for at least 3 sec allows changing the frequency at steps of 1 Hz inside the above mentioned range.

A wrong setting of the rated frequency can damage the electro pump.

Note: each modification of Fn is interpreted as a system change; hence FS, FL and FP will automatically take the default value.

5.1.2.3 rt: Setting the direction of rotation

Possible values: 0 and 1

If direction of rotation of the electro pump is wrong, it is possible to invert it by changing this parameter.
If you cannot check the direction of rotation of the motor directly, proceed as follows:

- Open a user and take note of the frequency (parameter Fr with MODE key from Go/Sb).
- Without changing the amount of water taken, change the rt parameter and take note of the frequency Fr again.
- The correct rt parameter is the one that requires a lower Fr frequency, with the same amount of water taken.

Warning: for some electro pumps Fr change between the two rt values could be unappreciable, so that it could be difficult to understand which is the right direction of rotation. In this case, we can repeat the above-mentioned experiment, but instead of taking note of the frequency, we can try taking note of the absorbed phase current ("C1" parameter with button MODE from Go/Sb). The correct rt value is the one requiring the lowest phase current C1.

5.1.2.4 od: Setting the operating mode of the PWM

Possible values: 1 and 2
The factory setting mode is 1, which adapts to most installations. If pressure oscillates and a change of GI and GP parameters is ineffective (see sec. 5.1.3.2 and 5.1.3.3), a switch to mode 2 can be helpful.

Important note. **GP** and **GI** parameter values change when switching from one operating mode to the other one. Moreover, the GP and GI values set in mode 1 are contained in a separate memory area from the GP and GI values set in mode 2. So for example, when you switch from mode 1 to 2, the GP value will be replaced by the one that was set in mode 2, but the GP value set in mode 1 will be restored when switching back to mode 1.
The same value has a different weight in one or in the other mode because the control algorithm is different.

5.1.2.5 rP: Setting the restart pressure drop

This parameter represents the pressure drop, with respect to the SP parameter value, that makes the pump restart.
Normally rP may be set from a minimum of 0.1 to a maximum of 1.5bar. In particular conditions (see sec. 5.1.1.1) this parameter can be automatically limited.

Note: When the controller board is controlling the PWM, the former device sets the parameter, so the user cannot modify it anymore. If communication is lost, rP takes its usual meaning and the stored value is automatically restored.

5.1.2.6 Ad: Setting the interconnection address

With the PWM system it is possible to build composite booster sets, with or without the “Da Vinci” controller board’s supervision.

The admissible values of Ad are: "--", 1, 2 and 3 with the following meanings:

- “--“ Communication is disabled.
- “1“ the board acts as secondary PWM.
- “2“ the board acts as primary PWM.
- “3“ communication with the controller board.

5.1.2.6.1 Setting the address for booster sets composed by 2 PWM

Without any additional component couples of PWM devices can be organised in booster sets using different operating strategies and communicating trough a serial interconnection. In this kind of installation on the two units an address (“Ad”) must be set, whose value must be set to “1” on one device and to “2” on the other one.

WARNING: If you set the same “Ad” value on two interconnected PWMs, communication doesn't establish and we can have regulation malfunctioning.

WARNING: Correct operation of a multi-channel booster set is possible only if the different channels are electrically and hydraulically identical: same electro pumps, same PWM, same manifolds, same valves and duct geometry.

When communication is not working (due to a wrong setting of the “Ad” value, to some wiring mistake or to some other cause) the two PWM will work as two completely independent devices but they will show the impossibility to communicate by blinking the display while showing “Go” or “Sb”.

When the “Ad” value is correctly set, some regulation parameters are aligned on the primary and the secondary PWM. In particular, the following parameters are copied from the former to the latter:

- SP: Setting of the set-point pressure.
- rP: Setting of the restarting pressure drop.
- Eb: Enabling of the booster pump.
- CM: Method of role exchange.
- P1: alternate set point P1, selectable with input 2.

Note: During operation it is possible to change all parameters of PWM (both those that are aligned at communication establishment and the others) on each of the two devices. If one of the above mentioned parameter's value is changed on one PWM, it will change on the other PWM too.

Alignment of these values happens each time you restart a booster set or even when a general reset happens.

Different usage strategies of interconnected electro pumps are described in sec. 5.1.2.7 "Eb: Enable booster". For a description of role exchange policies between devices organised in a booster set, see 5.1.3.7 "CM: Role exchange policy in booster sets".

5.1.2.6.2 Setting address for connection to "Da Vinci" controller board

ATTENTION: Correct operation of a multi-channel booster set is possible only if the different channels are electrically and hydraulically identical: same electro pumps, same PWM, same manifolds, same valves and duct geometry.

The use of "Da Vinci" controller board allows assembly of booster sets made of up to 4 PWM.
In this kind of installation it is necessary that on all PWMs that are connected to the controller board the Ad address equals "3".

When communication is not working (due to a wrong "Ad" value, to a wiring mistake, or to some other cause), the PWMs will operate as two completely independent devices, but they will show the impossibility to talk to each other and to the controller board by blinking the display while showing "Go" or "Sb".

When PWM is operating under the controller board's supervision, the latter reads all parameters from the PWM and controls PWM operation. Managing of booster sets is done from the controller board and becomes unavailable from the PWM menu.
During operation with the controller board the following features are disabled on the PWM:
- Input 2 operation
- SP: set-point pressure setting
- rP: restart pressure setting

At the same time a new menu becomes available by pressing the MODE key. The new menu is called "AS" and indicates the configuration type assigned to the PWM by the controller board.
For a detailed description of this operating mode, please see the "Da Vinci" instruction manual.

5.1.2.7 Eb: Enable booster

When two PWM units are interconnected, if operation of one PWM is not able to satisfy the user's needs, it is possible to activate two electro pumps at the same time.

Note: Irrespective of the value of "Ad" (primary or secondary PWM), the PWM that regulates will be called "PWM leader" (it modulates frequency) while the PWM that works only at the highest frequency will be called "PWM booster".

The allowed values to enable booster operation Eb are: 1 and 2:

- Eb = 1: The leader-booster operating mode is disabled, so only one electro pump at a time will be active.

  If during operation the leader electro pump is not able to satisfy the user, the booster electro pump will not be turned on.

- Eb = 2: The leader-booster operating mode is enabled; so 2 electro pumps can be activated at the same time.

  If during operation the leader electro pump is not able to satisfy the user, the booster electro pump is also turned on and works at the maximum frequency, while the leader machine

continues modulating the rotation frequency according to the user demand, so that the formerly halted pump now works more than the formerly working one.

Section 5.1.3.7 “CM: Role exchange policy in booster sets “ explains how to choose the way the booster and leader roles are exchanged between the pumps.

5.1.3 Technical assistance Displays and settings (access keys MODE & SET & +)

5.1.3.1 tB: Setting of reaction time of the water lack blockage

Setting of the reaction time of the water lack blockage allows selecting the time (in seconds) taken by the PWM system to indicate the lack of water in the electro pump. Changing this parameter may be useful if it is known that there is a delay between the moment in which the electro pump is turned on and the moment in which it actually starts delivering. An example could be that of a system where the suction pipe of the electro pumps is particularly long and has some little leakages. In this case it can happen that the suction pipe unloads when the system is in stand by, even if there is water, and that the electro pump takes some time to reload, to deliver flow and to bring pressure to the system.

5.1.3.2 GP: Setting the proportional coefficient of the PI

Typically, the proportional term must be increased for systems characterized by elasticity (for PVC and wide pipelines) and decreased in case of rigid installation (iron and tight pipelines).
In order to have a constant pressure in the system, PWM performs a PI control action on the measured pressure error. The power that must be supplied to the electro pump is calculated as a function of the mentioned error values. The control action’s behaviour depends on the values of the GP and GI parameters. In order to adapt to behaviour of the various hydraulic system types, PWM allows selecting different parameter values that differ from the ones set by the factory.
For most systems, the factory default values of GP and GI parameters are the optimal ones. If there are some regulation problems, these settings may be modified.

5.1.3.3 GI: Setting the integral coefficient of the PI

If a big pressure fall happens due to a quick increase of the flow, or to a slow response of the system, the GI value should be increased. Vice versa, pressure oscillations around the set point value may be reduced by decreasing the GI value.

Note: If the PWM is far away from the electro pump hydraulic elasticity affects the PI control and, as a consequence, pressure regulation.
This is a typical case in which a decrease of the GI value is needed.

Important: To obtain a satisfactory pressure regulation, you usually need to adjust both GP and GI.

5.1.3.4 FS: Setting the maximum rotation frequency of the electro pump

FS sets the maximum rotation frequency of the pump; values can range between Fn - 20% and Fn + 20% (absolute max. rating = 154 Hz). It can be useful to obtain a greater hydraulic power (though for a limited time) or to set an upper limit to the rotating frequency.
FS automatically aligns to Fn each time a new Fn value is set.
Overdriving of the electro pump is useful to cover high flow requests without the pressure of the system dropping below the set-point one. This operation condition cannot last too long because the temperature increase it causes could damage the motor.
Anyway, to allow overdriving to be exploited, PWM allows to set a maximal frequency of operation higher than the rated one. Thanks to a thermal model of the installed motor, the highest frequency supplied to the electro pump can be limited in case of excessive increase of the temperature. The value of the highest rotation frequency (FS) can be therefore be reached only when the motor is cold and it drops down to Fn (the rated frequency) as the windings’ temperature increases.
On the other hand, if necessary, PWM allows setting a maximum frequency of operation lower than Fn. In this case, in any condition of regulation, the electro pump will never be driven at a frequency higher than FS.

5.1.3.5 FL: Setting the min. frequency

With FL we set the min operating frequency of the pump. FL values may range between 0 Hz and 60% of Fn; for example, if Fn =50 Hz, FL can be chosen between 0 and 30 Hz.
FL is reset to the default each time we set a new Fn value.

5.1.3.6 Ft: Setting the low flow rate threshold

The parameter “Ft” allows to set a minimum flow rate under which the PWM turns off the pump.

5.1.3.7 CM: Role exchange policy in booster sets

When two PWM units form a booster set the two electro pumps roles (leader or booster, as defined in note below) can be exchanged according to two different policies.

Note: Irrespective of the value of "Ad" (primary or secondary PWM), the PWM that regulates will be called “PWM leader” (module the frequency) while the PWM that works only at the highest frequency will be called “PWM booster”.

The admissible values for the exchange policy CM are: 00 and 01.

- CM = 00: The primary PWM is always the regulation leader and the secondary PWM will be active as a booster (if Eb = 2) or as spare device (if Eb = 1). If the secondary machine remains unused for 23 hours, it becomes the leader until it has accumulated one minute of regulation (a washing of the impeller is performed).

  If during operation the leader electro pump is unable to satisfy the user and the secondary electro pump is configured as a booster (Eb = 2), the latter will work at maximum frequency, while the leader PWM will continue modulating rotation frequency according to the user demand.
  If the user demand decreases, the booster machine is turned off, while the leader machine continues regulating.

- CM = 01: The primary and secondary PWM act as leader or as booster alternatively. The roles are exchanged each time the leader PWM goes into stand-by mode or after 2 hours of continuous activity.

  If during operation the leader electro pump is unable to satisfy the user and the secondary electro pump is set as a booster (Eb = 2), the latter will work at maximum frequency, while the leader PWM will continue modulating rotation frequency according to the user demand.
  If the user demand decreases, the leader machine goes in stand-by mode and becomes the booster (i.e. off), while the booster machine becomes the leader (and starts regulating at variable speed).

Setting of the enable parameter of the booster operation Eb is described in sec. 5.1.2.7 “Eb: Enable booster“.

For each of the two exchange modes, if one of the machines fails, the other becomes the leader and carries out regulation at constant pressure up to its maximum available power.

5.1.3.8 AE: Enabling the anti-frost/anti-block function

This function helps to avoid mechanical blocks in case of long inactivity or in case of low temperature and is obtained by running the pump.

When the anti-frost function is enabled, if the PWM measures a temperature that is too low, with a risk of frost, it automatically starts running the electro pump at low speed. Keeping water in movement reduces frost risks in the pump. In this way breaking risks due to ice are reduced in the PWM also, thanks to power dissipation. Vice versa, if the temperature is in a safe range, a long inactivity can prevent the mechanical parts from operating or cause formation of residuals inside the pump; to avoid this an anti-block cycle is performed every 23 hours.

5.1.3.9 Setup of the IN1, IN2 and IN3 auxiliary digital inputs with the i1, i2 and i3 parameters.

The function assigned to each of the digital inputs IN1; IN2; IN3 may be activated or modified by means of the i1; i2; i3 parameters.

The allowed values of i1, i2 and i3 are:

0 → function disabled
1 → function active when input is high2 → function active when input is low
The only exception is i3, whose allowed values also include 3, 4 and 5(for details see sec. 5.1.3.9.3)

Connection is described in sec. 2.4.

5.1.3.9.1 I1: Setting function of input 1 (external float)

i1 = 00: Input disabled.
Status of input 1 is ignored, so an external float will never cause an error for lack of water. Consequently, “F1” will never appear on the display.

i1 = 01: Lack of water from external float (NO)

IN1: 0 (not energized input)	Normal operation
IN1: 1 (energized input)	“F1” alarm on display and system lock (lack of water from external float)

Note In order that the system locks and displays the “F1” error, the input must be at 1 (energized) for at least 1 sec.
When an “F1” error condition occurs, the input must be at 0 (not energized) for at least 30 sec. before the system unlocks.

i1 = 02: Lack of water from external float (NC)

IN1: 00 (not energized input)	Alarm F1 on display and system lock (lack of water from external float)
IN1: 01 (energized input)	Normal operation

Note: In order that the system locks and displays the “F1” error, the input must be at 0 (not energized) for at least 1 sec.
When the “F1” error condition is set, the input must be at 1 (energized) for at least 30 sec. before the system unlocks.

5.1.3.9.2 I2: Setting function of inlet 2 (active set-point selection: “SP” or “P1”)

i2 = 00: Input disabled.
Irrespective of the input status, SP is always used as a pressure set point.

i2 = 01: 2 set point system (NO)

IN2: 00 (not energized input)	active set point is SP. In normal display mode “Go” or “Sb” is displayed; the read-only GS parameter value is “SP” (provided that no anti-freeze/anti-block procedure is being performed)
IN2: 01 (energized input)	active set point is P1. In normal display mode ”Go” or “Sb” is displayed; the read-only GS parameter value is “P1” (provided that no anti-freeze/anti-block procedure is being performed)

Note: In order that the system uses P1 as its set point, the input must be at 1 (energized) for at least 1 sec. When P1 is the active set point, the input must be at 0 (not energized) for at least 1 sec, before SP returns to be the active set point.

i2 = 02: 2 set point system (NC)

IN2: 0 (not energized input)	active set point is P1. In normal display mode “Go” or “Sb” is displayed; the read-only GS parameter values “P1” (provided that no anti-freeze/anti-block procedure is being performed)
IN2: 1 (energized input)	active set point is SP. In normal display mode “Go” or “Sb” is displayed; the read-only GS parameter value is “SP” (provided that no anti-freeze/anti-block procedure is being performed)

Note: In order make the system work with P1 as its active set-point, the input must be at 0 (not energized) for at least 1 sec. Conversely, if the active set-point is P1, the input must be at 1 (energized) for at least 1 sec, before SP returns to be the active set-point.

5.1.3.9.3 I3: Setting function of input 3 (general system enabling)

i3 = 00: Input disabled.

Irrespective of the input status, the system remains enabled and the possible pressures are only SP and P1 (see: i2). “F3” never appears on the display.

i3 = 01: General enable (NO)

IN3: 0 (not energized input)	System enabled, “GO” or “Sb” is displayed.
IN3: 1 (energized input)	System enabled, “F3” is displayed.

i3 = 02: General enable (NC)

IN3: 0 (not energized input)	System disabled, “F3” is displayed.
IN3: 1 (energized input)	System disabled, “GO” or “Sb” is displayed.

i3 = 03: General enable (NO)

This case is identical to that with i3 = 1 except that each time the system switches from disabled to enabled state all recoverable blocks are cancelled.

i3 = 04: General enable (NC)

This case is identical to that with i3 = 2 except that each time the system switches from disabled to enabled state all recoverable blocks are cancelled.

i3 = 05: Block Reset

In this case each time the input IN3 goes from state 0 (not energized) to state 1 (energized) all recoverable blocks are cancelled

Table summarising the configuration of the digital inputs IN1, IN2, IN3			
Value	**Parameter**		
	i1	i2	i3
00	Input is ignored, “F1” never appears	Input is ignored. SP is the only set-point	Input is ignored, “F3” never appears
01	Water lack from external float connected to IN1 (NO)	Set-point: SP or P1, depending on IN2 (NO)	IN3 acts as general enable signal (NO)
02	Water lack from external float connected to IN1 (NC)	Set-point: SP or P1 depending on IN2 (NC)	IN3 acts as general enable signal (NC)
03			IN3 acts as general enable signal (NO) + recoverable blocks are cancelled
04			IN3 acts as general enable signal (NC) + recoverable blocks are cancelled
05			Recoverable blocks are cancelled

Table 10: inputs configuration

5.1.3.10 P1: Setting the set-point P1 function of input 2

When the parameter i2 is set at a value other than zero, input 2 is used to select one of the two settable set points. The first is SP (see 5.1.1.1) and the second is P1.

5.1.3.11 O1: Setting output 1 function: alarm active

5.1.3.12 O2: Setting output 2 function: pump operating

Assigning the parameters that associate functions with the digital outputs OUT1; OUT2				
Assigning the parameters	Value			
	00	01	02	03
o1	Function disabled Contact always open	Function disabled Contact always closed	The contact closes if a blockage error occurs	The contact opens if a blockage error occurs
o2	Function disabled Contact always open	Function disabled Contact always closed	When the electro pump is operating the contact closes	When the electro pump is operating the contact opens

Table 11: Assigning output function

5.2 Display-only parameters

From normal operation status the following quantities can be displayed by pressing the MODE key:

5.2.1 User's parameters (accessed by the MODE key)

From normal operation status (Sb or Go on the display) after pressing the MODE key once, "Fr" appears on the display.
All the following quantities can be displayed at further MODE key pressures.

5.2.1.1 Fr: Display of the current rotation frequency (in Hz)

5.2.1.2 UP: Display of pressure (measured in bar)

If pressure exceeds 15 bar, the display keeps showing "15".

5.2.1.3 C1: Display of the electro pump's phase current (in A)

5.2.1.4 AS: Display of the configuration with "Da Vinci"

This parameter appears on MODE menu when communication between "Da Vinci" controller board and PWM and shows how the former configured the latter. The possible cases are:
rd ("ready") the PWM is regulating according to the set points decided by the controller board
rS the PWM is configured as spare device and is activated in case of block of other devices
dS ("disable") the PWM is disabled and it is never activated.

5.2.1.5 UE: Display of the version of the software with which the appliance is equipped

5.2.2 MONITOR menu (accessed by SET & - keys)

From normal operating status hold down the “SET” and “-“ (minus) keys simultaneously until “UF” appears on the display.
Now it is possible to display all the following parameters, by pressing each time the MODE key.

5.2.2.1 UF: Display of the flow

Display of the instantaneous flow in uncalibrated internal measure unit.

5.2.2.2 ZF: Display of zero flow

Display of the value read by the flow sensor on which zero was acquired (with electro pump turned off).
During normal operation the PWM will use this parameter to turn off the electro pump.

5.2.2.3 FM: Display of the maximum rotation frequency (in Hz)

5.2.2.4 tE: Display of the temperature of the power stages’ temperature (measured in °C)

5.2.2.5 bt: Display of the printed circuit temperature (measured in °C)

5.2.2.6 GS: Display of running status

SP pump is maintaining pressure “SP”
P1 pump is maintaining pressure “P1” (input 2 active)
AG anti-frost/anti-block procedure is being performed

5.2.2.7 FF: Display of fault history queue (+ & - to scroll)

There is a queue of 16 positions for containing the last 16 faults that have occurred during system operation. By pressing the “–“ key you can go back in history and stop at the oldest fault, whereas by pressing the “+” key you can go forward in history and stop at the most recent fault.
The decimal point identifies the last fault that occurred in chronological order.
The history queue contains at most 16 positions. Each new fault is inserted in the most recent position (decimal point). Each fault after the sixteenth overwrites the oldest one in the queue. The fault history queue is updated as new faults occur, but never erased. Manual reset and turning off of the appliance do not erase the fault history queue.

6 PROTECTION SYSTEMS

PWM is equipped with protection systems that preserve the pump, the motor, the power line and the PWM self. If one or more protections act, the one with higher priority is signalled on the display. According to the error type, the electro pump can be turned off, but when normal operating conditions are restored, the error status can be cancelled either immediately or after a certain time.
In case of block due to a lack of water (Bl), of block due to over current in the electro pump’s motor (oC), of block due to overcurrent condition of the output stage (oF), or of block due to direct short circuit between the phases of the output terminals (SC), we can try to manually exit the error condition by pressing and releasing the + and – keys simultaneously. If the error condition persists, it is necessary to remove the cause of the anomaly.
In case of overcurrent, the protection acts in two ways:

- Maximum frequency limiting as temperature increases over a potentially dangerous value

The second type of protection is used on:
- power devices
- supply capacitor
- printed circuit

It acts when a potentially dangerous temperature is reached, by gradual decrease of the maximum frequency of rotation FS. The purpose is that of reducing power dissipation thus protecting the PWM against overheating. Once the alarm cause disappears, the protection is automatically disabled and normal operation conditions are restored. Intervention of one or more of these protections can only decrease the frequency FS by no more than 20%.

The three protection systems don't cause a block and don't produce any error message, but keep track of their intervention by insertion of an alarm in the fault history (see sec. 5.2.2.7).

Note: during intervention of such protections a FR frequency of rotation smaller than the expected one could be displayed.

If the temperature of the final output stage or of the printed circuit is not successfully limited by the mentioned protections, an overtemperature blockage will occur.

Warning on the fault history queue	
Display indications	**Description**
Lt	Overtemperature on the power devices alarm (tE > 85°C)
LC	Overtemperature on capacitor alarm
Lb	Overtemperature on printed circuit alarm (bt > 100°C)

Table 12: Warning on the fault history queue

Error conditions	
Error and status conditions	
Display indications	**Description**
bL	Blockage due to lack of water
bP	Blockage due to disconnected pressure sensor
LP	Blockage due to low supply voltage
HP	Blockage due to high rectified voltage
Ot	Blockage due to overheating of the power output stages (tE > 100°C)
Ob	Blockage due to overheating of the printed circuit (bt > 120°C)
OC	Blockage due to overcurrent in the electro pump motor
OF	Blockage due to overcurrent in the output stages
SC	Blockage due to direct short circuit between the phases of output terminals
EC	Blockage due to incorrect setting of the rated current (rC) or rated frequency (Fn)
E0...E7	Blockage due to internal error 0...7
F1	Status / Blockage due to input 1 status
F3	Status / Blockage due to input 3 status

Table 13: Error conditions

“bL” Blockage due to lack of water

In no flow conditions the system turns off the pump. If the pressure is lower than the set point one, the display shows a lack of water message.

If you wrongly set a pressure set point higher than the pressure that the electro pump is able to supply, the system will sign “lock due to lack of water” (bL) even if there is no lack of water. So you should lower the set-point pressure at a reasonable value that usually does not exceed 2/3 of the of the installed electro pump’s head.

Note: The PWM system operates at constant pressure. This regulation is appreciable if the hydraulic system downstream from the system is properly sized. Systems with too narrow pipes lead to a

pressure loss that the system cannot compensate. The result is that pressure is constant on the PWM device but not on the user.

“bP” Blockage due to a fault of pressure sensor

If the PWM does not detect the presence of a pressure sensor the pump blocks and the “bP” error is signalled. This error condition begins as soon as the problem is detected and ends automatically 10 sec after the correct conditions are restored.

"LP" Blockage due to low supply voltage

This error condition occurs when the line voltage at the supply terminals falls below 180V and is reset only automatically when the voltage at the terminal rises above 200V.
If the wiring section is insufficient, this block may occur when the electro pump is started even if a higher voltage is measured when the PWM is in stand-by mode.

"SC" Blockage due to direct short circuit between the phases of the output terminal

PWM is equipped with protection against short circuit that may occur between the phases U, V, W of the "PUMP" output terminal. When this block status is indicated, you should remove the short circuit and carefully check the wiring integrity and the installation in general. Once these checks have been made you can try to recover from the error by simultaneously pressing the “+” and “–“ keys; **anyway, this will have no effect until 10 seconds have elapsed from the moment in which the short circuit occurred.**
Whenever a short circuit occurs, an event counter is increased and saved in the permanent memory (EEPROM).

AFTER THE HUNDREDTH SHORT CIRCUIT THE MACHINE BLOCKS PERMANENTLY AND IT WILL NO LONGER BE POSSIBLE TO UNBLOCK IT!

6.1 Manual reset of error condition

In error status the operator can recover from the error by forcing a new attempt, which is obtained by simultaneous pressure of the “+” and “–“ keys.

6.2 Automatic reset from error conditions

The system automatically attempts to recover from the following error conditions:

- "bL" Blockage due to lack of water
- "LP" Blockage due to low supply voltage
- "HP" Blockage due to high supply voltage (or high internal voltage due to a sudden motor braking)
- "ot" Blockage due to overheating of the power output stages
- "oC" Blockage due to overcurrent in the pump
- "oF" Blockage due to overcurrent in the output stages

For example, if the electro pump blocks due to lack of water, the PWM will automatically start a series of tests in order to ensure that the machine really has no water and that this condition is permanent. If a recovery attempt succeeds (e.g. if water has come back), the tests will stop and the PWM will return to normal operation.

The following table shows the procedures performed by PWM when different error conditions occur:

Automatic reset of error conditions		
Display indications	**Description**	**Sequence of automatic reset**
BL	Blockage due to lack of water	- One attempt every 10 min. for a total of 6 attempts - One attempt every 1 hour for a total of 24 attempts - One attempt every 24 hours for a total of 30 attempts
LP	Blockage due to low supply voltage (lower than 184V for PWM 230 and 320V for PWM 400)	- Recovery happens when line voltage returns to be higher than 184 V for PWM 230 and than 320 V for PWM 400
HP	Blockage due to high supply voltage (higher than 264V for PWM 230 and 457V for PWM 400)	- Recovery happens when voltage returns to be lower than 264 V for PWM 230 and lower than 457 V for PWM 400
ot	Blockage due to overheating of the power stages (tE > 100°C)	- Recovery happens when the power stages' temperature falls below 85°C
ob	Blockage due to overheating of the printed circuit (bt > 120°C)	- Recovery happens when the printed circuit's temperature falls below 100°C
oC	Blockage due to overcurrent of the pump	- One attempt every 10 min. for a total of 6 attempts
oF	Blockage due to overcurrent in the output stages	- One attempt every 10 min. for a total of 6 attempts

Table 14: Automatic reset of error conditions

7 SWITCHING TO MANUAL MODE

A greater flexibility is achievable by using the system in manual mode. In this operating mode the PWM performs no pressure control action and the user can force it to perform some actions, according to the possibilities listed in this chapter.

To access to this operating mode, hold down the 

keys simultaneously for at least 5 seconds. Activation of manual mode is signalled by a blinking display.

In this operating mode the 

key allows to scroll through all parameters and the  and  keys increase and decrease the modifiable parameters.
The functions of the keys and their combinations are summarized in Table 15 and explained in the sections that follow.

Warning: In this mode all controls and protection systems of the PWM are disabled and any device connected to the PWM (PWM or controller board) cannot control regulation.

Use of the keys.	
Pressed keys	**Action**
"SET" & "-" & "+"	Press them together until the display shows "MA" (5 sec.)
"+"	Increases the parameter's value if it does not yet equal the maximum allowed one (only frequency and rotation direction of the pump)
"-"	Decreases the parameter's value if it does not yet equal the minimum allowed one (only

	frequency and rotation direction of the pump)
"MODE"	Moves to the next item in the following menu: FP **Setting** of the frequency (measured in Hz); must be ≤ than the FS value. UP Display of pressure (in bar) C1 Display of the electro pump phase current (in A) rt **Setting** of the direction of rotation UF Display of flow ZF Display of zero flow
"MODE" & "-"	The electro pump runs at the set frequency as long as the keys are held down
"MODE" & "-" & "+" (2 seconds)	The electro pump remains operating at the set frequency The electro pump may be turned off by pressing "SET" (if "SET" is pressed one more time, PWM will exit manual mode)
"SET" & "-"	Change the rotation direction of the electro pump (active only if the electro pump is operating)
"SET"	Press it to stop the pump or to exit manual mode

Table 15: Keys usage in manual mode

Note: In manual mode, error recovery, obtained by pressure of the  keys, is effective only on "BI" and "OF" error conditions.

7.1 Parameters in manual mode

7.1.1 FP: test frequency setting

The test frequency in Hz it is displayed and can be modified by pressing the "+" and "-" keys.
The default value is Fn – 20% and values cannot exceed FS.

7.1.2 UP: Display of pressure (in bar)

7.1.3 C1: Display of the phase current of the electro pump (in A)

7.1.4 rt: setting the direction of rotation

The "rt" parameter allows to revert the pump's rotating direction by pressing the  and  keys and to display two possible status codes: "00" or "01". The function is active also when the motor is running.

Note: in manual mode, irrespective from the current menu item, it is always possible to revert the direction of rotation by simultaneous pressure of the  and  keys for 2 seconds; this feature is available only while the pump is running.

An arrow on the pump's motor frame is normally used to show direction of rotation.
If you cannot check the direction of rotation of the motor you may proceed as described in sec. 5.1.2.3 or switch to manual mode and proceed as follows:

1st method

- Open a user, start the pump with  keys and take note of the pressure.

  If a manometer is not available, press  until the pressure "UP" is displayed.

- Without changing the amount of water taken, change the direction of rotation directly by simultaneously pressing the 

and  keys (see sec. 7.2.3) and take note of the pressure again while the pump is running.

- The right direction of rotation is obtained when pressure is maximized.

- Press 

to stop the pump.

2nd mode

- Open a user, start the pump by simultaneously pressing the 

keys and take note of the pressure(if a manometer is not available, you can display the pressure “UP” by scrolling the menu with the 

key).

- Without changing the amount of water taken, change the rotating direction “rt” with the  keys while the pump is taking water from the user circuit and the pump is running. Take note of the pressure again.

- The right value of “rt” is obtained when the pressure is maximized.

7.1.5 UF: display of the flow

7.1.6 ZF: display of Zero Flow

7.2 Controls

When PWM is in manual mode, it is always possible, irrespective from the displayed parameter, to perform some controls as described in the following sections.

7.2.1 Temporary start of the electro pump

Simultaneous pressure of the 

keys causes the pump’s start at FP frequency and the running status persists as long as the two keys remain pressed.
When the pump is ON the display blinks quickly (200mSec ON, 100mSec OFF).
When the pump is OFF the display blinks slowly (400msec ON, 100mSec OFF).

7.2.2 Quick-start of the pump

Simultaneous pressure of the 

keys for 2 seconds causes the pump’s start at FP frequency. The running status persists until the 

key is pressed.

When the pump is ON the display quickly flashes (200mSec ON, 100mSec OFF).
When the pump is OFF the display slowly flashes (400msec ON, 100mSec OFF).

Note: in manual mode if the pump is stopped pressure of the 

key restores normal operating mode, but if the pump is running pressure of the key only stops the pump.

7.2.3 Direction of rotation reversal

By simultaneous pressure of the 

keys for at least 2 seconds, the pump's rotating direction is reverted (this function is active only while the motor is running). To understand which is the right direction of rotation, see sec. 5.1.2.3 and 7.1.4.

8 RESET AND FACTORY SETTINGS

8.1 General system reset

To restart the appliance without disconnecting the power supply, press the 4 keys simultaneously.

8.2 Factory settings

The PWM leaves the factory with a set of default parameters' values (shown on Table 16).

Name	Description	Factory parameters
SP	Set-point pressure	3.0 bar
rC	Rated current of the electro pump	0.0 A
Fn	Rated frequency	00
rt	Direction of rotation	00
od	Operating mode	01
rP	Restarting pressure	0.5 bar
Ad	Interconnection address	"--"
CM	Role exchange policy	01
tb	Reaction time of the water lack blockage	10 sec.
GP	Proportional coefficient	1.0 for PWM230 0.6 for PWM400 – PWM400/7.5
GI	Integral coefficient	1.0 for PWM230 1.2 for PWM400 – PWM400/7.5
FS	Max. Rotation frequency	00
FL	Min. Rotation frequency	00
Ft	Low flow rate threshold	15
AE	Enabling anti-blockage function	01
I1	Input 1 function	01
I2	Input 2 function	01
I3	Input 3 function	01
P1	P1set-point selectable by input 2	2.5 bar
o1	Output 1 function	02
o2	Output 2 function	02
FP	Manual mode test frequency	Fn - 20%

Table 16: Factory settings

8.3 Restoring of factory settings

To reset factory values turn off the system, press and keep the SET and + keys pressed while the system turns on again and release them only when the "EE" appears on the display.
This way PWM automatically restores all parameters to their factory values (factory settings permanently saved in flash memory are copied on EEPROM and verified).
After having set all parameters, PWM goes back to normal operation.

9 APPENDIX

9.1 Pressure loss

Pressure loss diagram of PWM

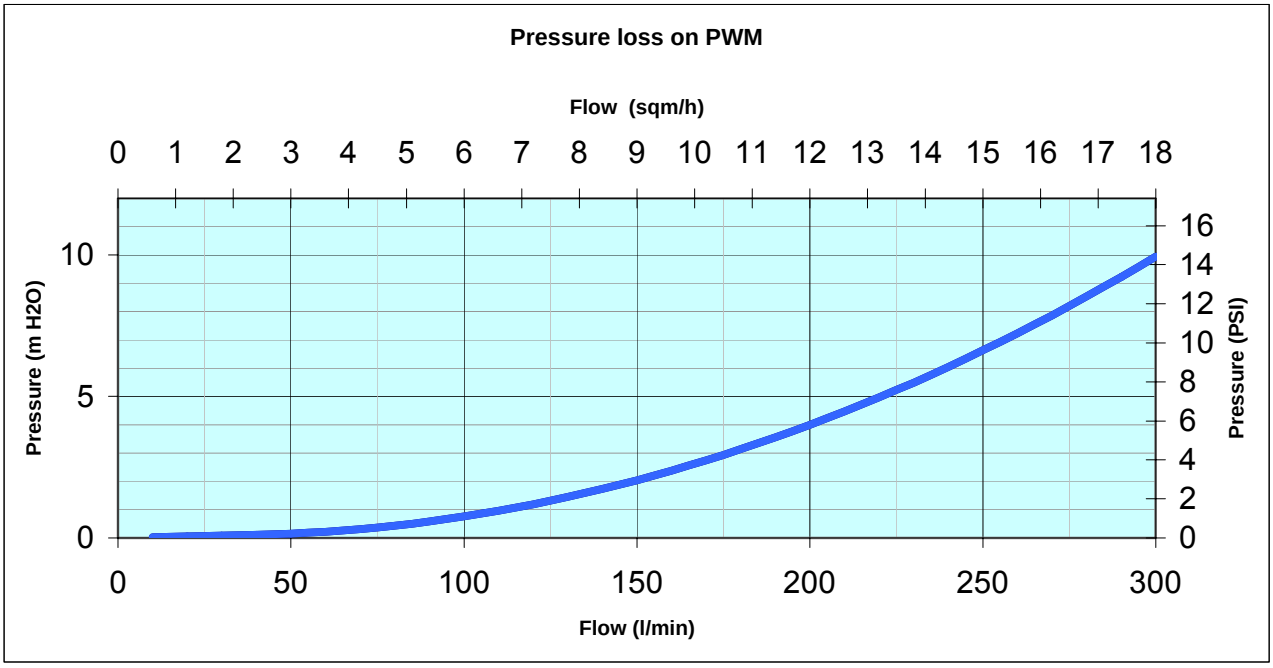


Figure 16: PWM's pressure loss

9.2 Energy saving

Use of the PWM system instead of traditional On/Off systems drastically reduces energy consumption. To show this, an example that represents the consumption of a 1,5 kW pump in the two cases follows. The comparison is done with the same yearly flow demand.

Test performed with a 1,5 KW electro pump and prevalence set to 30 mH2O					
Flow (l/min')	**Statistic use of flow**	**Direct insertion consumption (KW)**	**Consumption with PWM (KW)**	**Power difference (KW)**	**Energy saved in one year (8760 hours) (Kwh)**
5	20%	1,295	0,185	1,110	1.945
10	40%	1,388	0,555	0,833	2.917
20	20%	1,480	0,740	0,740	1.296
40	9%	1,573	1,110	0,463	365
70	6%	1,794	1,570	0,224	118
100	5%	1,850	1,850	0,000	0
			Total yearly saving (KWh)		**6.641**

Table 17: Energy saving