

感谢您选用中科科仪分子泵控制器！同时，您将享受到我们为您提供的全面、真诚的服务！

FD 系列分子泵控制器具有高品质、多功能、低噪音特点，该系列控制器能够适用多种分子泵。

本手册为用户提供安装调试、操作使用、故障诊断及日常维护的有关注意事项，在安装、使用前请仔细阅读，正确操作。本手册随控制器一起提供，并请妥善保管，以备以后查阅和维护使用。

阅读提示：



危险！会引起人身伤亡和财产损失的不正确操作与安装



警告！会引起人身伤害和财产损失的不正确操作与安装



注意！会影响控制器性能的不正确操作

Thank you for selecting the controller for molecular-pump of KYKY! Meanwhile, you will enjoy our complete and sincere service!

Featured with top quality, multi-function and low noise, FD series controller of molecular-pump can be applied to various molecular-pumps.

This manual provides users with precautions regarding installation, commissioning, operation, trouble diagnosis and daily maintenance. Please read it carefully before any installation and usage is commenced to ensure a proper operation. This manual shall be available together with the controller, and should be well kept for future reference and convenience of maintenance.

Tips for reading:



Danger! Improper operation and installation that may cause casualties and property loss.



Warning! Improper operation and installation that may cause physical injury and property loss.



Attention! Improper operation that may affect performance of controller.

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1、安全使用

 危险！	
★	严禁将控制器安装在有易燃易爆气体的场所，否则可能引起爆炸。
★	只有合格的专业人员才可以对控制器进行安装、配线及操作、维护。
★	控制器后面板接地端子（GROUND）必须可靠接地（接地阻抗不大于 4Ω ）。
★	控制器驱动输出连接器内部电源的公共点（CM）不允许与输入电源的零线短接。
★	控制器上电前，要确信正确接线，驱动输出连接器接触可靠。
★	实施配线或维护前，务必关闭电源。
★	控制器前面板上的停止键，不能切断电源，因此不能作为安全键使用。
★	切断电源后的短时间（10 分钟）内或直流母线电压高于 36V 时，不要进行维修操作，切勿触摸内部电路及器件。
 警告！	
★	控制器通电前，必须确认输入电源电压等级正确。
★	不要将螺丝刀、螺丝等金属物掉入控制器内。
★	不要将控制器安装在阳光照射的地方，不要堵塞控制器的散热孔。



注意！

- ◆ 在对控制器进行操作之前，请您仔细阅读本手册。
- ◆ 上电后，请观察控制器所识别的分子泵型号，是否与实物相符，若不相符，切不可运行。
- ◆ 应定期检查控制器输入输出接线是否正确及其电线是否老化。
- ◆ 电机经常低速运转工作时，要对电机采取额外冷却措施。
- ◆ 不要在控制器输出端连接可变电阻器和电容以试图提高功率因数。
- ◆ 不要在控制器输出与分子泵之间安装断路器，如果必须安装，则要保证断路器仅在控制器输出电流为零时动作。
- ◆ 控制器的存放、安装应避开强振动、强腐蚀、高粉尘、高温、高湿的环境。
- ◆ 分子泵控制器的防护等级为 IP20。
- ◆ 如长时间不用，应间隔一定时间（建议一个月）给控制器通电一次。

2、产品简介

2.1 产品型号及铭牌

分子泵控制器产品型号示例见图 2-1，铭牌示例如图 2-2 所示（以 FD-II 为例）。



图 2-1 产品型号示例

分子泵控制器铭牌如图 2-2 所示：（以 220VAC 输入为例）

KYKY	北京中科科仪技术发展有限责任公司
型 号	FD-II
输 入	AC 1PH 220V 50/60Hz
输 出	3PH 0.75KW 17A 0~66V 0.00 ~ 1300Hz
 FPS200007S2C02929000154	

图 2-2 产品铭牌示例

2.2 产品一览表

型 号	额定输出 电流（A）	结构形式	冷却方式
FD-I	7	C01	风冷
FD-II	17	C02	风冷
FD-IIB	17	C04	风冷
FD-III	23	C03	风冷

2.3 产品外观

分子泵控制器外观结构为金属壳。

FD-II 产品外形、结构部件及尺寸如图 2-3-1 所示。

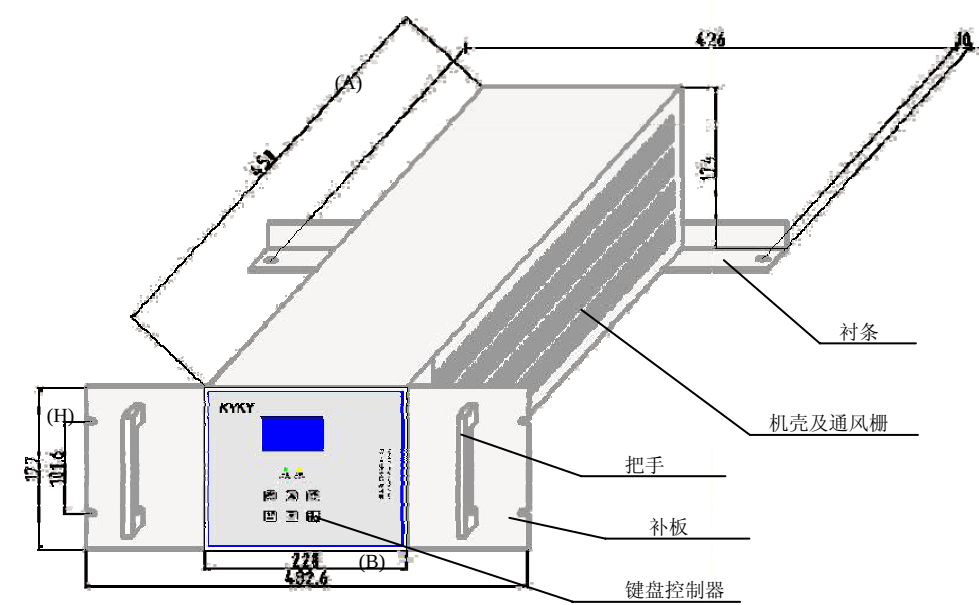


图 2-3-1 FD-II 外观尺寸图

FD-IIB 产品外形、结构部件及尺寸如图 2-3-2 所示。

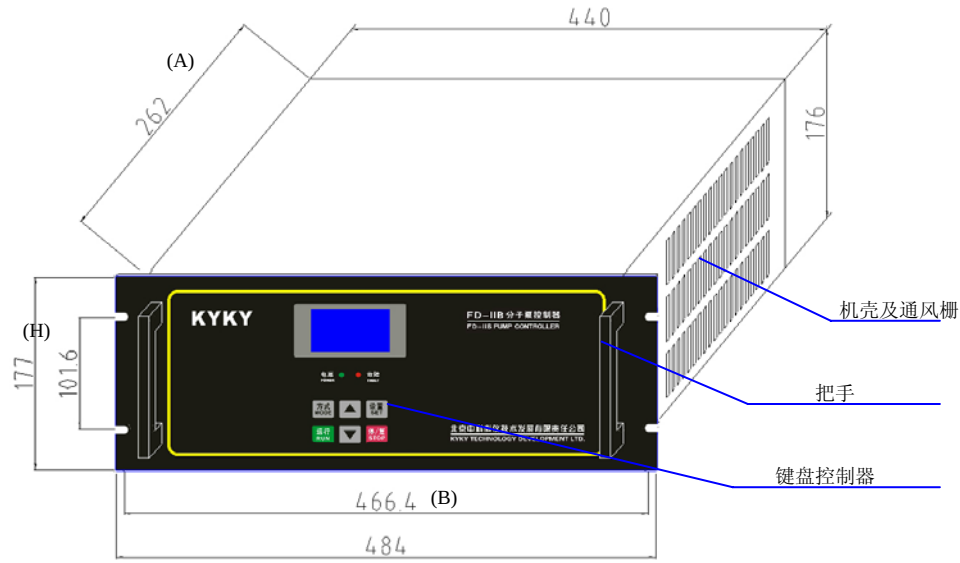


图 2-3-2 FD-IIB 外观尺寸图

FD-III 产品外形、结构部件及尺寸如图 2-3-3 所示。

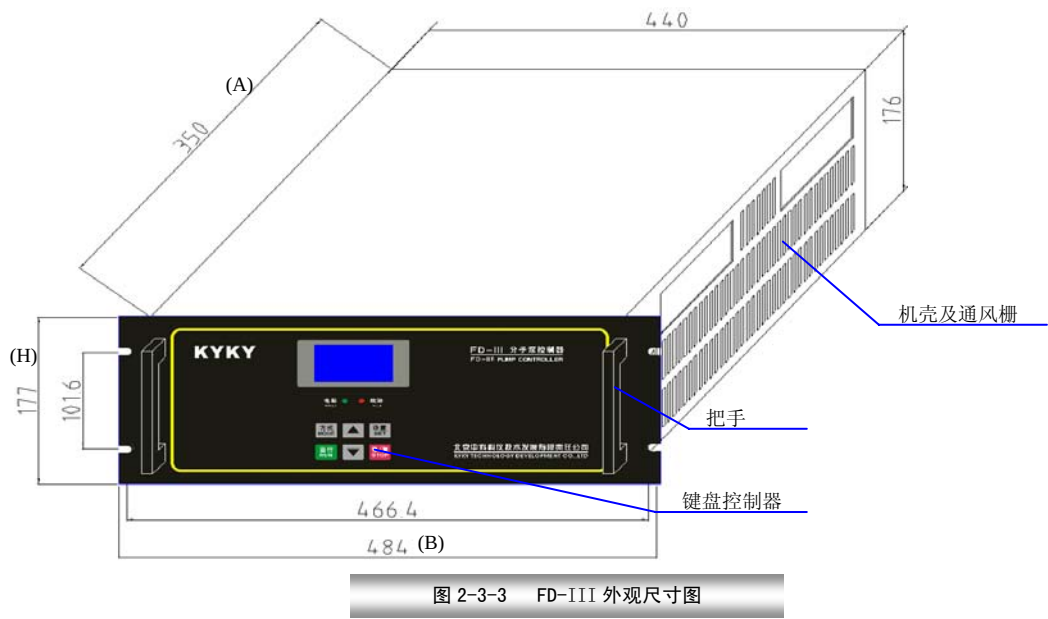


图 2-3-3 FD-III 外观尺寸图

2.4 FD 系列控制器与分子泵型号匹配表

控制器	配用分子泵型号
FD-II, FD-II B (注 1)	FF-160/500F
	FF-160/620C、FF-160/620E
	FF-160/620、FF-160/620T、FF-160/620N、 FF-160/620Z、FF-160/620BZ、FF-160/620CN、 FF-160/620NE、FF-160/620ZE、FF-160/500G
	FF-160/700、FF-160/700E
	FF-200/1200N、FF-200/1200BZ
	FF-200/1200C、FF-200/1200CE
	FF-200/1300、FF-200/1300E
	F-250/1500、F-250/1500T、 F-250/1500N、FF-250/1500E
	FF-250/1600、FF-250/1600E
	FF-250/1800、FF-250/1800E
FD-III	F-400/3500

注 1: FD- II, FD- II B 分子泵控制器会自动识别分子泵负载的型号，并按照最佳的参数运行。

2.5 性能指标

型号	FD- II (B) 500K	FD- II (B) 600K	FD- II (B) 600H	FD- II (B) 700K	FD- II (B) 1200K
输入电压 ^{备注 1}	220VAC $\pm$ 10%	220VAC $\pm$ 10%	220VAC $\pm$ 10%	220VAC $\pm$ 10%	220VAC $\pm$ 10%
	110VAC $\pm$ 10%	110VAC $\pm$ 10%	110VAC $\pm$ 10%	110VAC $\pm$ 10%	110VAC $\pm$ 10%
输入电源频率	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)
最大输出功率	750W	750W	750W	750W	750W
输出频率	400 $\pm$ 10 Hz	450 $\pm$ 10 Hz	600 $\pm$ 10 Hz	600 $\pm$ 10 Hz	400 $\pm$ 10 Hz
输出电压	$\leq$ 66VAC	$\leq$ 66VAC	$\leq$ 66VAC	$\leq$ 66VAC	$\leq$ 66VAC
正常工作电流	$\leq$ 4A	$\leq$ 4A	$\leq$ 5A	$\leq$ 2A	$\leq$ 5A
最大启动电流	$\leq$ 14A	$\leq$ 14A	$\leq$ 12A	$\leq$ 9A	$\leq$ 16A
启动加速时间	3min20sec	4min30sec	6min	4min	6min
关机减速时间	6min	6min	8min	11min	10min
重量	18.5kg	18.5kg	18.5kg	18.5kg	18.5kg
型号	FD- II (B) 1200H	FD- II (B) 1300K	FD- II (B) 1600K	FD- II (B) 1800K	FD-III
输入电压 ^{备注 1}	220VAC $\pm$ 10%	220VAC $\pm$ 10%	220VAC $\pm$ 10%	220VAC $\pm$ 10%	220VAC $\pm$ 10%
	110VAC $\pm$ 10%	110VAC $\pm$ 10%	110VAC $\pm$ 10%	110VAC $\pm$ 10%	110VAC $\pm$ 10%
输入电源频率	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)
最大输出功率	750W	750W	750W	750W	1100W
输出频率	450 $\pm$ 10 Hz	400 $\pm$ 10 Hz	450 $\pm$ 10 Hz	450 $\pm$ 10 Hz	225 $\pm$ 10 Hz
输出电压	$\leq$ 66VAC	$\leq$ 66VAC	$\leq$ 66VAC	$\leq$ 66VAC	$\leq$ 66VAC
正常工作电流	$\leq$ 5A	$\leq$ 3A	$\leq$ 5A	$\leq$ 4A	$\leq$ 8.5A
最大启动电流	$\leq$ 16A	$\leq$ 10A	$\leq$ 20A	$\leq$ 20A	$\leq$ 21A
启动加速时间	6min	6min	7min10sec	7min30sec	18min
关机减速时间	11min	11min	12min	15min	36min
重量	18.5kg	18.5kg	18.5kg	18.5kg	27.5kg
启动/停车控制	键盘、外控端子和上位机控制				
显示功能	液晶显示屏显示当前输出频率、输出电流、当前输出电压、故障类型以及功能码参数、操作参数和分子泵型号；两个 LED 指示灯指示控制器的上电状态和故障状态。				
保护功能	控制器输入欠压，过压，过流，过热，分子泵过载，限电流输出，过流及过热保护，用户密码错误，外部干扰保护				
环境条件	设备场所：无强烈腐蚀性气体和粉尘；环境温度： $-10^{\circ}\text{C}\sim+50^{\circ}\text{C}$ ； 环境湿度：90%以下（无水珠凝结现象）；振动强度：0.5g（加速度）以下				

备注 1:FD 系列控制器输入电压等级分为 110VAC 和 220VAC，订货时请特殊说明。

3、安装与配线

3.1 安装环境

- 无雨淋、水滴、蒸汽、粉尘及油性灰尘；无腐蚀、易燃性气体、液体；无金属微粒或金属粉末等。
- 环境温度在-10℃～+50℃范围内。
- 环境相对湿度必须在 90%以下，且无水珠凝结现象。
- 无强电磁干扰。
- 振动强度在 0.5g（加速度）以下。
- 控制器若安装在控制柜内，应保证控制柜内与外界通风流畅。

如图 3-1-1 所示。其周围应保证有效的通风空间

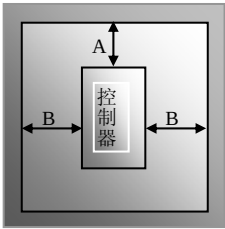


图 3-1-1 控制器安装示意图

下表给出控制器安装的间隙尺寸（推荐值）。

控制器类型	间隙尺寸	
FD-I	$A \geq 150\text{mm}$	$B \geq 50\text{mm}$
FD-II(B)	$A \geq 200\text{mm}$	$B \geq 100\text{mm}$
FD-III	$A \geq 200\text{mm}$	$B \geq 150\text{mm}$

3.2 外形尺寸

表 3-2 分子泵控制器产品尺寸一览表（注 1）

结构代号	外形尺寸(A×B×H)
C01	正在研发
C02	450×220×177
C03	350×440×177
C04	262×440×177

注 1 用户自行设计控制器机柜时请在机身左右两端至少各留出 8mm 的间隙。

3.3 分子泵控制器操作显示面板

分子泵控制器显示面板采取液晶显示方式，以 FD-II 为例说明，参见图 3-3-1。

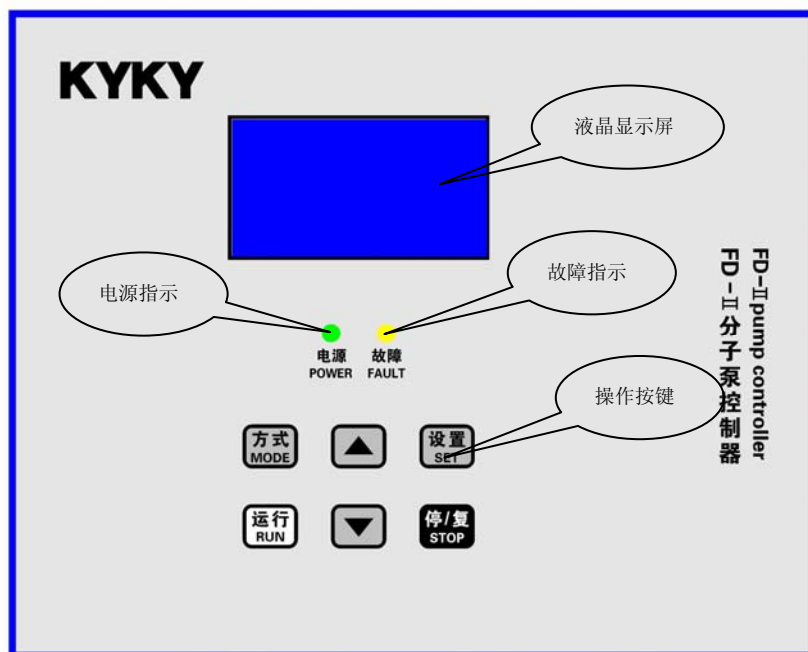


图 3-3-1 操作显示面板示意图

FD 系列分子泵控制器操作显示面板包含：

操作区和显示区。

操作区即按键区，包含六个功能键，

功能键内容及使用功能见表 3-3-2。

表 3-3-2 键盘按键说明

按 键	按 键 名 称	说 明
	“方式”键	供分子泵生产厂家使用
	“设置”键	供分子泵生产厂家使用
	“上升”键	供分子泵生产厂家使用
	“下降”键	供分子泵生产厂家使用
	“运行”键	在键盘操作模式下，启动系统主机投入运行。
	“停机/复位”键	该键为停机和复位键： 1): 系统停机，返回待机状态； 2): 故障状态下复位。

显示区可通过功能码 06 进行中文/英文切换，具体操作方式如下：

在待机界面下，按下“方式”键，进入功能区界面，然后按“▲”键，上升至 06，界面内容如下：

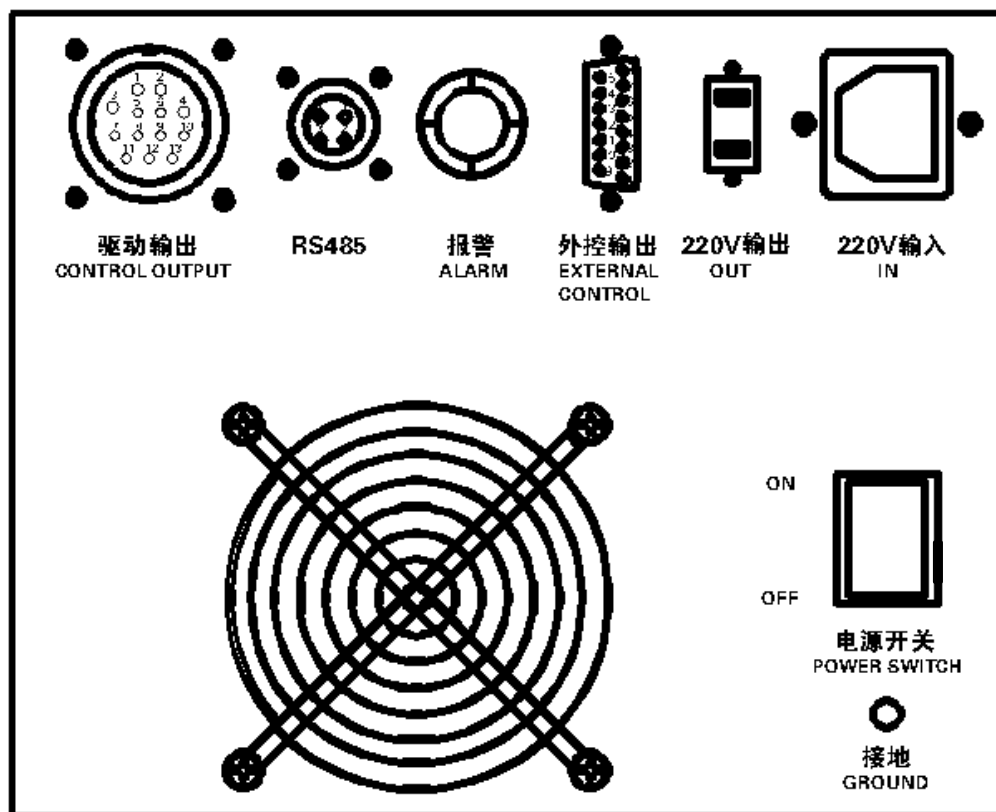
04 加速时间
05 减速时间
06 语言/LANGUAGE
07 获取泵类型方法

当“06 语言/LANGUAGE”处于闪烁状态时，按下“设置”键，进入参数设置区，界面内容如下：

中文/CHINESE
英文/ENGLISH

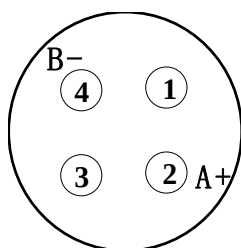
选择所需要的语言，使其处于闪烁状态，按下“设置”键，即设置成功。按下“方式”键，返回待机界面。

3.4 分子泵控制器 220VAC 输入后面板部件示意图



各部件功能简介

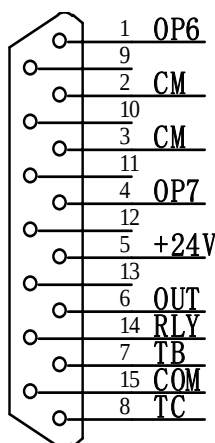
- 1、 电源开关 (POWER SWITCH): 控制器通/断电, 当开关打到“ON”位置, 控制器通电, 当开关打到“OFF”上时, 控制器断电。
- 2、 输入电源插座 (IN): FD 系列控制器电压等级分为 110VAC 和 220VAC, 订货时请具体说明, 电源输入为 220VAC, 内置 10A/250VAC 保险, 输入 110VAC 时, 内置 15A/250VAC 保险。
- 3、 接地端子 (GROUND): 此端子必须可靠接地, 接地阻抗不大于 4Ω 。
- 4、 报警 (ALARM): 当控制器出现意外情况时, 此蜂鸣器报警, 告知用户, 具体故障请查看液晶显示屏。
- 5、 RS485 通讯连接器: 485 通讯控制端子 A+、B-, 详细引脚见下图:



本控制器可采用上位机控制启动、停止、获取电压、电流、频率等参数并能监视运行、故障等状态。适用于一些要与其它外设一起受微机操作、控制的设备，可单独启动、停止，更适用于生产线上的群起群停。

注：通过微机串行通讯口控制运行时，若微机为 RS232 接口，需要使用 RS485/RS232 接口转换器。若微机为 RS485 接口，可直接连接。

6、外控输出（EXTERNAL CONTROL）：此为计算机插口，内有启动信号线、停车信号线、运行指示信号线和故障报警信号线，具体引脚定义分布见下图：



外控输出各引脚功能：

启动方式：1、2 脚（OP6、CM）平时处于外接继电器（或开关）的开路状态。要启动时接入一个瞬间无源短路信号，时间约 0.5S~1S，即可启动分子泵。也就是说把 1、2 脚短接一下，即可启动分子泵。

停止方式：3、4 脚（CM、OP7）平时处于外接继电器（或开关）的短路状态。要停止时接入一个瞬间无源开路信号，时间约 0.5S~1S，即可停止分子泵。也就是说把 3、4 脚断开一下，即可停止分子泵。

提示：继电器常闭、常开触点或开关的常闭、常开触点要求是无源的，否则会损害控制器电路。

正常输出（有源信号）：5、6 脚（+24V、OUT）在分子泵加速过程中无电压输出，分子泵运转正常后，5、6 脚输出 24VDC 电信号，最大电流 0.1A。

正常输出（无源信号）：14、15 脚（RLY、COM）可给出一个无电压触点正常输出信号。可控制蜂鸣器、灯或门电路。外接电压源的最大允许电压 24VDC，最大允许电流 0.1A。换句话说在分子泵加速过程中，14、15 脚为断开状态，分子泵运转正常后，14、15 脚为接通状态。

故障输出：7、8 脚（TB、TC）可给出一个故障输出信号（无电压触点输出信号）。可控制蜂鸣器、灯或门电路。

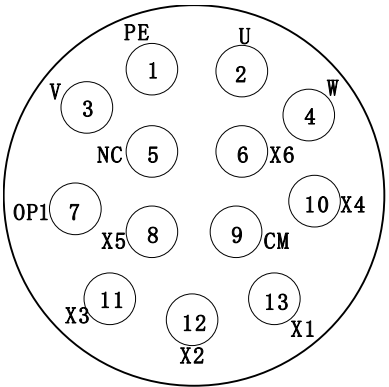
外接电压源的最大允许电压 24VDC，最大允许电流 0.1A。换句话说就是分子泵无故障时，7、8 脚为接通状态，有故障时为断开状态。

注：以上所说的外控启动，停止方式是在不影响前面板运行键、停止键功能下，多加一路外接控制启动、停止功能。在不用外控时，一定要把外控插头的 3、4 脚短路起来，并将外控插头与外控插座连接好，否则控制器不会受前面板控制。

特殊启动方式：有些用户需要只用一个键或只用一个端子就能控制开和关两种状态。方法介绍如下：将外控插头 1、2 脚短路，引出 3、4 脚接到一个外控开关或一个继电器触点上（要求是无源的）。常开时是停止，常闭时是启动。这时候面板控制失效。

注：切不可用输入电压 220VAC 或 110VAC 来做控制器的启动、停止输入信号。如果那样将会造成控制器的损害。

7、 驱动输出（CONTROL OUTPUT）：此连接器为 13 位，内有用于自动识别分子泵型号的信号线、电机驱动线和电机过热保护信号线，具体引脚分布见下图：



各引脚功能

引脚序号	引脚名称	出厂功能	规格
1	PE	控制器地线	接地阻抗不大于 4 Ω
2、3、4	U、V、W	电机驱动输出	额定电流见表 2.2
7	OP1	电机过热信号	高电平有效
9	CM	控制信号公共端	不允许与 PE 短接
6、8、10、11、12、13	X6、X5、X4、X3、X2、X1	用于自动识别分子泵型号的信号	不允许接有源信号

4、使用方法：

以 FD-11 为例说明：

- 1. 将分子泵上的 12 芯插座与控制器后面板上的 13 芯驱动输出插座用电缆线连接好。
- 2. 若控制器不使用外控功能，通电前务必将备件袋中的外控插头与控制器后面板上的外控插座连接好；若使用外控功能，请按照外控功能说明接线后将外控插头与外控插座连接好。
- 3. 接好电源线后开启控制器后面板上的电源开关，此时控制器自动识别分子泵的型号，如 FF-160/620，液晶显示屏显示待机状态，控制器的最高工作频率为“450.0” Hz，伴有闪烁。

待机界面内容如下：

北京中科科仪	
目标频率：	450.0
FF-160/620	
状态：待机	CN/EN

- 4. 确认控制器显示的分子泵型号与实物相符后，按下“运行”键，分子泵开始启动，液晶屏显示“转速追踪中…”。
- 转速追踪界面内容如下：

转速追踪中…

- 5. 一段时间后，液晶屏转入运行主界面，实时显示当前分子泵的转速、频率、电压值、电流值，直至加速完毕。
- 各类型控制器的加速时间参见技术性能表。
- 运行界面内容如下：

当前转速：	27000
当前频率：	450.0
当前电压：	55
当前电流：	5.1

- 6. 需要关机时，按下“停/复”键，此时液晶屏实时显示转速下降过程中的转速、频率、电压值、电流值，直至返回到待机状态，表示停机完毕，此时方可关闭电源开关。各类型控制器的减速时间参见技术性能表。
- 7. 使用中控制器判定出现故障时，控制器具有声、光报警及字符显示，故障代码参见故障代码表，需要解除报警时，可按控制键盘上的“停/复”键复位或关闭总电源开关，

注意，故障复位或者重新上电之后控制器都会自动重新识别分子泵型号，需要再次确认显示型号与实物是否相符，若识别错误，切不可运行。

8. 当控制器遇到突然输入电源中断故障，电源恢复后即可按“运行”键，液晶显示屏显示“转速追踪中”，一段时间后，液晶屏显示追踪到的分子泵当前的状态，直至达到最高工作频率。

5、故障代码

故障代码	故障类型
ERR	按键操作错误
OC	控制器过流保护
OL2	分子泵过流保护
SL	分子泵过载保护
OE	控制器过压保护
LU	控制器欠压保护
ESP	分子泵过热保护
OH	控制器过热保护

6、常见故障处理

故障现象	发生原因	处理方法
接通电源，打开后面板总电源开关，风扇不转	电源输入插座内部保险丝坏	更换新保险丝
	电源输入线接触不可靠	更换电源输入线
打开电源总开关，风扇转动，液晶屏不显示	控制器主板与液晶屏之间连接的网线接触不好或脱落	请与厂家联系
	液晶屏本身故障	请与厂家联系
液晶屏显示正常，电机不转	后面板驱动输出连接器接触不可靠	重新插拔连接器
	驱动输出连接器与分子泵之间的电缆坏	更换电缆
	电机堵转	减小负载
	U、V、W 输出不正常	断电再上电，或与厂家联系

电源跳闸	输入侧短路	检查输入连线
	空气开关容量过小	增加空气开关容量
	负载过重	减小负载
电机转速不稳	分子泵循环水未通，或水压、水流不正常	检查循环水
	系统漏气	检漏
控制器过流保护（OC）	输出侧短路	电机电缆是否破坏
	对旋转中的电机实施再启动	待电机完全停稳后再启动
控制器过压保护（OE）	输入电源电压偏高	检查输入电源电压是否正常
控制器欠压保护（LU）	输入电源电压偏低	检查电源是否正常
	输入电源掉电瞬间	正常指示
分子泵过流保护（OL2）	系统漏气，真空度极低	检查系统设备
分子泵过热保护（ESP）	系统长期漏气、真空度不高	检查系统设备
	循环水未打开或水量、水压不足	打开循环水或检查循环水
分子泵过载保护（SL）	分子泵加速中长期漏气，电流过大	检查系统设备
控制器过热保护（OH）	环境温度过高	降低环境温度
	风扇损坏	请与厂家联系
	控制器内部过脏	清洁进出风口及散热片
	安装位置不利通风	按手册中的要求安装，改善通风
	功率模块异常	请求厂家服务
通讯错误	控制器主板与液晶屏之间连接的网线接触不好或脱落	请与厂家联系
自动识别型号错误	自动识别信号电缆接触不好	重新插拔连接器，断电再上电
	自动识别信号电缆坏	更换电缆
	受电磁干扰的影响	排除旁边的干扰源，如继电器、接触器等

一、Modbus 概述

Modbus 是一种串行的，异步的通讯协议。Modbus 协议是应用于 PLC 或其他控制器的一种通用语言。此协议定义了一个控制器能识别使用的消息结构，而不管它们是经过何种网络传输的。

Modbus 协议不需要专门的接口，典型的物理接口是 RS485。

关于 Modbus 的详细资料，可查阅相关书籍或者向本公司索取。

二、FD 系列控制器 MODBUS 通信协议

(一) 整体说明

1、传输模式：

1)、ASCII 传输模式。每发送 1 Byte 的信息需要 2 个 ASCII 字符。例如：发送 31H（十六进制），以 ASCII 码表示 ‘31H’，包含字符 ‘3’、‘1’，则需要发送时需要 ‘33’，‘31’ 两个 ASCII 字符。

常用字符，ASCII 码对应表如下：

字符	‘0’	‘1’	‘2’	‘3’	‘4’	‘5’	‘6’	‘7’
ASCII 码	30H	31H	32H	33H	34H	35H	36H	37H
字符	‘8’	‘9’	‘A’	‘B’	‘C’	‘D’	‘E’	‘F’
ASCII 码	38H	39H	41H	42H	43H	44H	45H	46H

2)、RTU 模式。发送的字符以 16 进制数表示。例如发送 31H。则直接将 31H 送入数据包即可。

2、波特率

设定范围：2400, 4800, 9600, 19200, 38400

3、帧结构

如下表：

1) ASCII 模式

位元	功能
1	开始位(低电平)
8	数据位
0/1	奇偶校验位（无校验则该位无，有时 1 位）
1/2	停止位（有校验时 1 位，无校验时 2 位）

2) RTU 模式

位元	功能
1	开始位(低电平)
8	数据位
0/1	奇偶校验位(无校验则该位无, 有时 1 位)
1/2	停止位(有校验时 1 位, 无校验时 2 位)

4、错误检测

1) ASCII 模式

LRC 校验: 校验除开始的冒号及结束的回车换行符以外的内容。

LRC 校验的方法是将消息中的 8bit 的字节连续累加, 不考虑进位, 它仅仅是把每一个需要传输的数据(除起始位、停止位)按字节叠加后取反加 1 即可。

2) RTU 模式

CRC-16 (循环冗余错误校验)

CRC-16 错误校验程序如下: 报文(此处只涉及数据位, 不指起始位、停止位和任选的奇偶校验位)被看作是一个连续的二进制, 其最高有效位(MSB)首选发送。报文先与 X^{16} 相乘(左移 16 位), 然后看 $X^{16} + X^{15} + X^{14} + \dots + X^1$ 除, $X^{16} + X^{15} + X^{14} + \dots + X^1$ 可以表示为二进制数 11000000000000101。整数商位忽略不记, 16 位余数加入该报文(MSB 先发送), 成为 2 个 CRC 校验字节。余数中的 1 全部初始化, 以免所有的零成为一条报文被接收。经上述处理而含有 CRC 字节的报文, 若无错误, 到接收设备后再被同一多项式($X^{16} + X^{15} + X^{14} + \dots + X^1$)除, 会得到一个零余数(接收设备核验这个 CRC 字节, 并将其与被传送的 CRC 比较)。全部运算以 2 为模(无进位)。

习惯于成串发送数据的设备会首选送出字符的最右位(LSB-最低有效位)。而在生成 CRC 情况下, 发送首位应是被除数的最高有效位 MSB。由于在运算中不用进位, 为便于操作起见, 计算 CRC 时设 MSB 在最右位。生成多项式的位序也必须反过来, 保持一致。多项式的 MSB 略去不记, 因其只对商有影响而不影响余数。生成 CRC-16 校验字节的步骤如下:

- ①装如一个 16 位寄存器, 所有数位均为 1。
- ②该 16 位寄存器的高位字节与开始 8 位字节进行“异或”运算。运算结果放入这个 16 位寄存器。
- ③把这个 16 位寄存器向右移一位。
- ④若向右(标记位)移出的数位是 1, 则生成多项式 1010000000000001 和这个寄存器进行“异或”运算; 若向右移出的数位是 0, 则返回③。
- ⑤重复③和④, 直至移出 8 位。
- ⑥另外 8 位与该 16 位寄存器进行“异或”运算。
- ⑦重复③~⑥, 直至该报文所有字节均与 16 位寄存器进行“异或”运算, 并移位 8 次。
- ⑧这个 16 位寄存器的内容即 2 字节 CRC 错误校验, 被加到报文的最高有效位。

(二) 命令类型及格式

1、常用功能域功能代码的两种命令类型如下：

命令类型	名称	描述
03	读取保持寄存器的内容	在一个或者多个寄存器中取得当前值，最多不超过 10 个。
06	预置单寄存器	把具体的值装入保持寄存器

2、数据包格式：

1)、ASCII 模式

开始标志	地址域	功能域	数据域				LRC 校验		结束标志	
: (0X3A)	分子泵 控制器 地址	功 能 代 码	数 据 长度	数据 1		数据 N	LRC 高 字节	LRC 低 字节	回车 (0X0D)	换行 (0X0A)

2)、RTU 模式

起始标志	地址域	功能域	数据域	CRC 校验		结束标志
T1-T2-T3-T4	分子泵控 制器地址	功能代码	N 个数据	CRC 低字 节	CRC 高字 节	T1-T2-T3-T4

3)、ASCII 模式与 RTU 模式转换

对于一条RTU协议的命令可以简单的通过以下的步骤转化为ASCII协议的命令：

(1)、 把命令的CRC校验去掉，并且计算出LRC校验取代。

(2)、 把生成的命令串的每一个字节转化成对应的两个字节的ASCII码，比如0x03转化成0x30, 0x33 (0的ASCII码和3的ASCII码)。

(3)、 在命令的开头加上起始标记“:”，它的ASCII码为0x3A。

(4)、 在命令的尾部加上结束标记CR, LF (0x0D, 0x0A)，此处的CR, LF表示回车和换行的ASCII码。

所以以下我们仅介绍RTU协议即可，对应的ASCII协议可以使用以上的步骤来生成。

3、通讯地址及命令含义

该部分是通信的内容，用于控制分子泵控制器的运行，分子泵控制器状态及相关参数设定。

功能码参数地址表示规则：

1)、功能码号为参数地址表示规则：

高位字节：00 (16进制数)

低位字节：00~63 (最大范围) (16进制数) 每个区的功能码范围不一样。具体范围见说明书。

如：F14 (面板显示)，地址表示为000E (16进制数)； F67 (面板显示)，地址表示为0043 (16进制数)；

注意：

有些功能只能读取参数，不可更改；有些功能既不可读取参数，也不可更改参数；有些参数在分子泵控制器处于运行状态时，不可更改；有些参数不论分子泵控制器处于何种状态，均不可更改；更改功能码参数，还要注意参数的范围，单位，及相关说明，以免出现不可预料的结果。

2)、以不同种类参数作为地址

（本部分所表示的地址及参数描述均为 16 进制，例如 1000 表示十进制的 4096）

1、运行状态参数

参数地址	参数描述（只读）
1000	输出频率
1001	输出电压
1002	输出电流
1003	分子泵控制器状态： 00：待机 01：运行 02：操作错误（err） 03：短路保护（OC） 04：直流过压（OE） 05：保留 06：RLU 07：过流（OL2） 08：分子泵过载（SL） 09：分子泵过热（ESP） 0A：欠压（LU） 0B：分子泵控制器过热（OH）

2、控制命令

参数地址	参数描述（只写）
2000	命令内容含义： 0003：减速停机 0004：自由停机 0008：运行（无方向） 0009：故障复位

2001	锁定参数 0001: 解除系统锁定（远程控制的锁定） 0002: 锁定远程控制（在解锁之前任何远程控制命令无效）
------	--

3、读写参数不正常响应

命令描述	功能码区	数据区
从机参数应答	功能码区的最高位变为 1。	命令内容含义 0001: 不合法功能代码 0002: 不合法数据地址 0003: 不合法数据 0004: 从机设备故障

读写功能参数的回复命令如下：

例 1：RTU 模式下，将 01 号控制器的 F04（加速时间）改为 10.0 秒。

主机请求：

地址	功能码	寄存器高字节	寄存器低字节	写参数状态高字节	写参数状态低字节	CRC 低字节	CRC 高字节
01	06	00	04	00	64	C9	E0

功能码 F04

10.0 秒

从机正常应答：

地址	功能码	寄存器高字节	寄存器低字节	写参数状态高字节	写参数状态低字节	CRC 低字节	CRC 高字节
01	06	00	04	00	64	C9	E0

功能码 F04

正常响应

从机不正常时的应答：

地址	功能码	不正常代码	CRC 低字节	CRC 高字节
01	86	04	43	A3

功能码最高位置 1：从机故障

例 2：读 02 号分子泵控制器的输出频率、输出电压、输出电流、分子泵控制器状态。

主机请求：

地址	功能码	第一个寄存器的 高位地址	第一个寄存器的 低位地址	寄存器的 数量的高位	寄存器的 数量的低位	CRC 低字节	CRC 高字节
02	03	10	00	00	04	40	FA

通讯参数地址 1000H

从机正常应答：

地址	功能码	字节数	数据高字节	数据低字节	数据高字节	数据低字节	数据高字节	数据低字节	数据高字节	数据低字节	CRC 低字节	CRC 高字节
02	03	08	13	88	00	39	00	3C	00	01	4E	4B

输出频率 输出电压 输出电流 运行

2 号分子泵控制器的输出频率为 500.0Hz, 输出电压 57V, 输出电流 6.0A。

例 3：1 号分子泵控制器运行

主机请求：

地址	功能码	寄存器高字节	寄存器低字节	写参数状态高字节	写参数状态低字节	CRC 低字节	CRC 高字节
01	06	20	00	00	01	43	CA

通讯参数地址 2000H 运行

从机正常应答：

地址	功能码	寄存器高字节	寄存器低字节	写参数状态高字节	写参数状态低字节	CRC 低字节	CRC 高字节
01	06	20	00	00	01	43	CA

正常响应

从机不正常时的应答：

地址	功能码	不正常代码	CRC 低字节	CRC 高字节
01	86	01	83	A0

功能码最高位置 1 不合法功能代码(假设)

例 4：读 2 号分子泵控制器的 04（加速时间）、05（减速时间）的值

主机请求：

地址	功能码	寄存器高字节	寄存器低字节	寄存器的数量的高位	寄存器的数量的低位	CRC 低字节	CRC 高字节
02	03	00	04	00	02	85	F9

通讯参数地址

读寄存器个数

从机正常应答：

地址	功能码	字节数	第一个参数状态高字节	第一个参数状态低字节	第二个参数状态高字节	第二个参数状态低字节	CRC 低字节	CRC 高字节
02	03	04	03	E8	00	78	49	61

实际为 100.0

实际为 12.0

从机不正常时的应答：

地址	功能码	不正常代码	CRC 低字节	CRC 高字节
02	83	04	B0	F3

功能码最高位置 1 分子泵控制器故障

(三) 有关附加说明

通讯过程中表示：

频率的参数值=实际值×10

时间的参数值=实际值×10

电流的参数值=实际值×10

电压参数值=实际值×1

功率参数值=实际值×100

版本号参数值=实际值×100

说明：参数值为数据包实际发送的值。实际值为该参数在分子泵控制器内的实际值。上位机在收到参数值后除以相应的比例系数得到分子泵控制器相应参数的实际值。

注意：向分子泵控制器发送命令时数据包内的数据不考虑小数点。所有数据的值不能大于 65535，否则数据溢出。

三、与通讯相关的功能码

分子泵控制器通讯用到的参数如下表：

功能码	功能定义	设定范围	出厂值
70	分子泵控制器地址	1~247	1
71	奇偶校验选择	0: 无校验 1: 奇校验 2: 偶校验	0
72	波特率选择	0: 2400 1: 4800 2: 9600 3: 19200 4: 38400	3
76	Modbus 模式选择	0: ASCII 模式 1: RTU 模式	0

在转速追踪模式下可以进行读运行状态参数、功能码的当前值、写控制命令、写功能码操作。

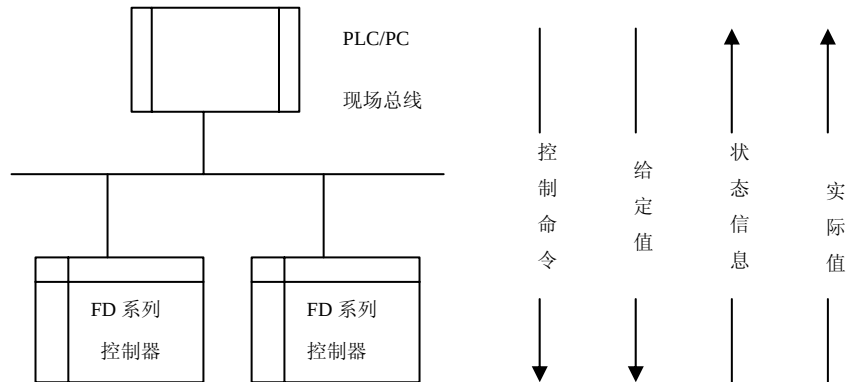
在用 PLC 或者其他智能设备远程控制分子泵控制器的时候，要注意上表中与通讯有关功能码的设置。确保通讯两端设备的通讯参数一致。

四、物理接口连接

(一)、接口说明

RS485 的通信接口位于控制器后面的 RS485 通讯插口中，具体引脚定义详见 3.4 后面板部件示意图的引脚含义。

(二)、现场总线结构



现场总线连接图

分子泵控制器采用 RS485 的半双工通信方式。485 总线要采用手拉手结构，而不能采用星形结构或者分叉结构。星形结构或者分叉结构会产生反射信号，从而影响到 485 通信。

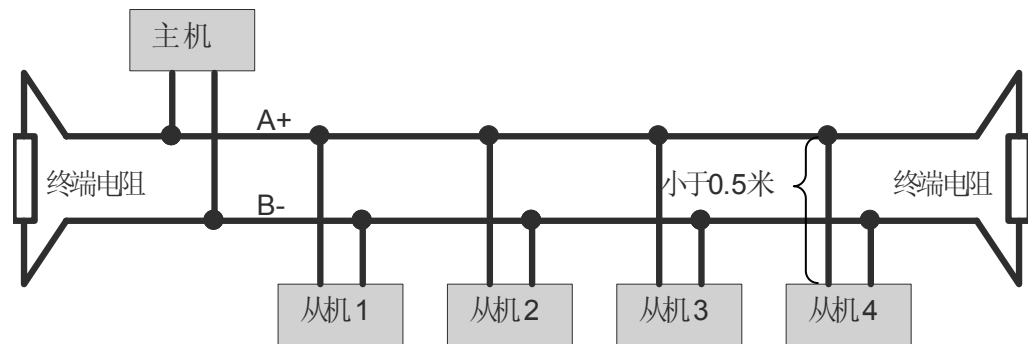
布线一定要选用屏蔽双绞线，尽量远离强电，不要与电源线并行，更不能捆扎在一起。

需要注意的是，半双工连接中同一时间只能有一台分子泵控制器与上位机通信。如果发生两个或者多个分子泵控制器同时上传数据则会发生总线竞争。不仅会导致通信失败，还可能使某些元件产生大电流。

(三)、接地和终端

RS485 网络的终端要使用 120Ω 的终端电阻，用来削弱信号的反射。中间网络不能使用终端电阻。

RS485 网络中的任何一点都不能直接接地。网络中的所有设备都要通过自己的接地端良好接地。需要注意的是，在任何情况下接地线都不能形成封闭回路。



系统连接图

接线时要考虑计算机/PLC 的驱动能力及计算机/PLC 与分子泵控制器之间的距离。如果驱动能力不足需要加中继器。



所有的安装接线，必须在分子泵控制器断电的情况下进行。

I. Safe Operation

	Danger!
★ Controller is prohibited to be installed in a place with flammable or explosive gases, which may cause explosion. ★ Only qualified personnel are allowed for any installation, wiring, operation and maintenance over controller. ★ Grounding terminal (GROUND) in the rear panel of the controller has to be well grounded (grounding impedance not more than 4 Ω). ★ No short-circuit connection is allowed between the common point (CM) of the internal power source for drive output connector for the controller and zero line of input power source. ★ Make sure that proper wiring has been conducted and connection is secured for drive output connector before power is supplied to controller. ★ Power has to be switched off before any wiring or maintenance is conducted. ★ The stop button on the front panel of controller cannot disconnect power and therefore can never be used as safety button. ★ No maintenance can be made within the short moment (10 minutes) after power disconnection or when voltage of DC busbar is higher than 36V. Never touch internal circuit or components.	
	Warning!
★ Make sure that input voltage is correct in degree prior to connection of controller. ★ Never drop any metal like a screwdriver or screw into the controller. ★ Never install controller in sunlight, or block heat-dispersion holes of controller.	



Attention!

- ◆ Please read this manual carefully before any operation on this controller.
- ◆ The controller of molecular pump should be stored and installed in a place away from strong vibration and corrosion, highly-concentrated dust, and high temperature and humidity.
- ◆ Make regular check over input and output wiring of controller to see if they are correct and if its wires are ageing.
- ◆ Extra cooling measures should be taken for the motor in case it is always running at low speed.
- ◆ Never connect a rheostat or capacitance at the output end of controller for the purpose of trying to increase power factor.
- ◆ Never install a breaker between output of controller and molecular pump. Should a breaker is really required, ensure that it only acts when output current of controller is zero.
- ◆ The controller of molecular pump has a protection degree of IP20.
- ◆ Should it be idled for a long time, make power connection to the controller at a certain interval (preferably one month).

II. Product Description

2.1 Model and Nameplate

Refer to Fig 2-1 for the illustration to the product model of control source of molecular pump and Fig 2-2 for the nameplate (taking FD-II for instance).

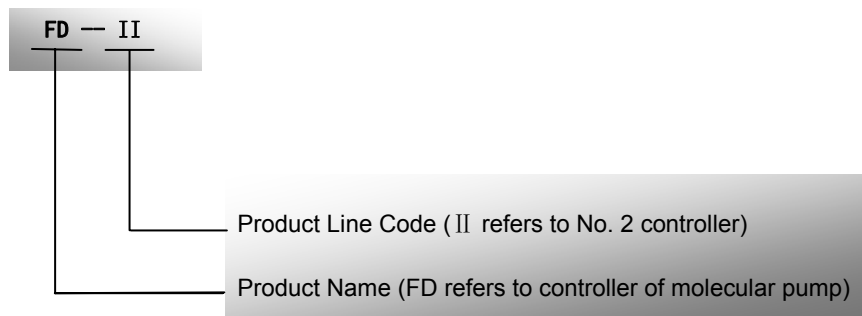


Fig 2-1 Illustration to Product Model

See Fig 2-2 for nameplate for controller of molecular pump: (taking 110V input for instance)

KYKY	KYKY TECHNOLOGY DEVELOPMENT LTD.
MODEL	FD-II
INPUT	AC 1PH 110V 50/60Hz
OUTPUT	3PH 0.75KW 17A 0~66V 0.00 ~ 1300Hz
 FPS200007S1C02929000154	

Fig 2-2 Nameplate Illustration

2.2 List of Products

Model	Rated Output Current (A)	Structure	Cooling Mode
FD-I	7	C01	Air Cooling
FD-II	17	C02	Air Cooling
FD- II B	17	C04	Air Cooling
FD-III	23	C03	Air Cooling

2.3 Appearance

The controller of molecular pump has its exterior structure of metal casing.

The appearance, structure components and dimensions of the FD-II product are shown as in Fig 2-3-1.

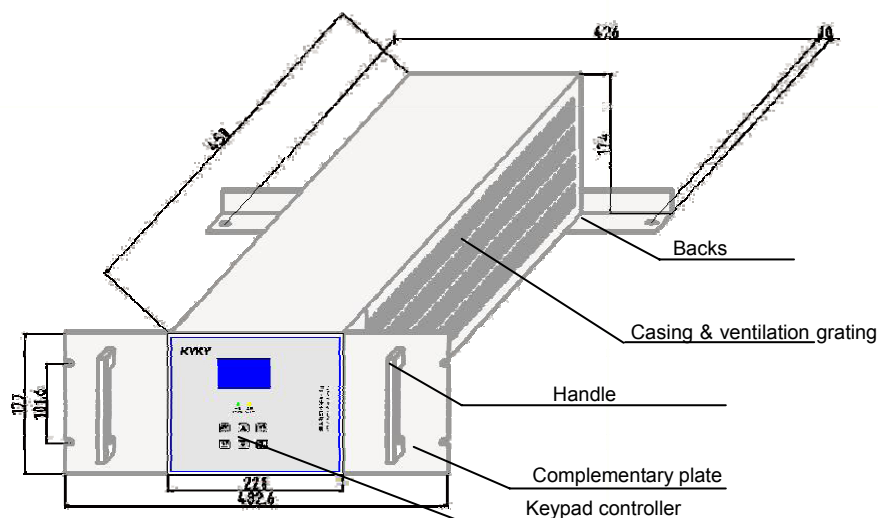


Fig 2-3-1 FD-II Apparent Size

The appearance, structure components and dimensions of the FD-IIB product are shown as in Fig 2-3-2.

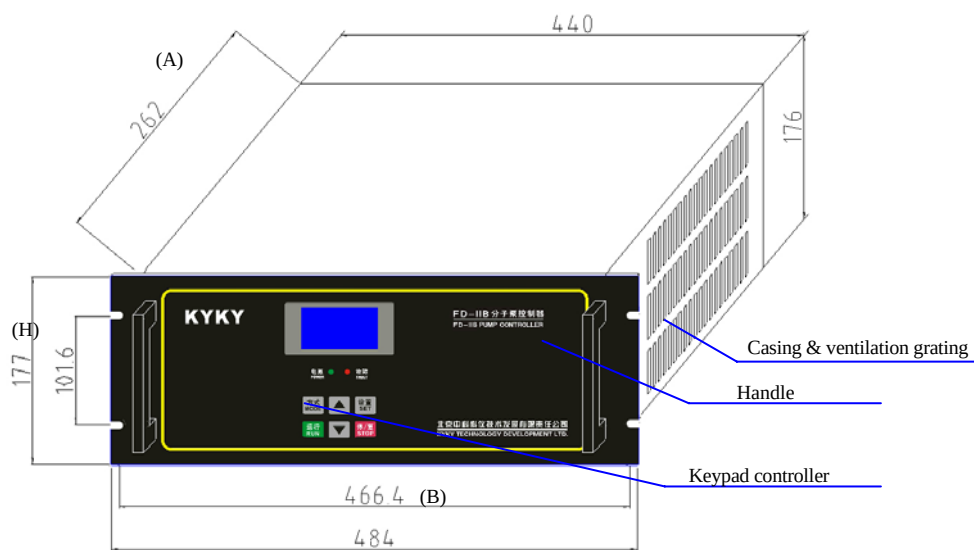


Fig 2-3-2 FD-IIB Apparent Size

The appearance, structure components and dimensions of the FD-III product are shown as in Fig 2-3-3.

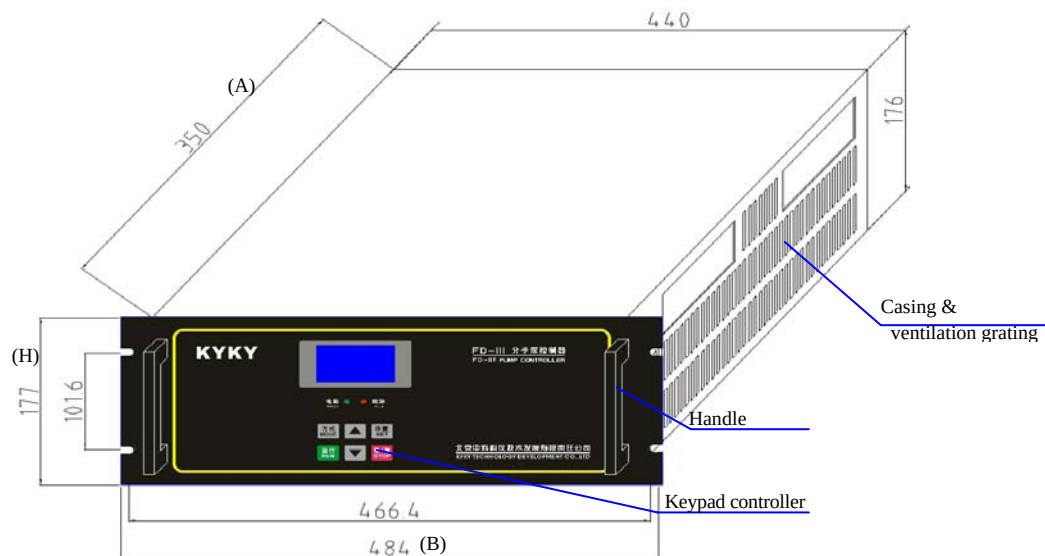


Fig 2-3-3 FD-III Apparent Size

2.4 Model Matching Table for FD Series Controller and Molecular Pump

Controller	Applicable Model of Molecular Pump
FD-II&FD-IIB (note1)	FF-160/500F
	FF-160/620C、FF-160/620E
	FF-160/620、FF-160/620T、FF-160/620N、 FF-160/620Z、FF-160/620BZ、FF-160/620CN、 FF-160/620NE、FF-160/620ZE、FF-160/500G
	FF-160/700、FF-160/700E
	FF-200/1200N、FF-200/1200BZ
	FF-200/1200C、FF-200/1200CE
	FF-200/1300、FF-200/1300E
	F-250/1500、F-250/1500T、 F-250/1500N、FF-250/1500E
	FF-250/1600、FF-250/1600E
	FF-250/1800、FF-250/1800E
FD-III	F-400/3500

Note1: Molecular pump controller can automatically recognize the model of pump load, and run by the optimal parameters.

2.5 Performance Index

Model	FD- II (B) 500K	FD- II (B) 600K	FD- II (B) 600H	FD- II (B) 700K	FD- II (B) 1200K
Input voltage ^{Note1}	220VAC $\pm$ 10% 110VAC $\pm$ 10%	220VAC $\pm$ 10% 110VAC $\pm$ 10%	220VAC $\pm$ 10% 110VAC $\pm$ 10%	220VAC $\pm$ 10% 110VAC $\pm$ 10%	220VAC $\pm$ 10% 110VAC $\pm$ 10%
Input frequency	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)
Max output power	750W	750W	750W	750W	750W
Output frequency	400 $\pm$ 10 Hz	450 $\pm$ 10 Hz	600 $\pm$ 10 Hz	600 $\pm$ 10 Hz	400 $\pm$ 10 Hz
Output voltage	$\leq$ 66VAC	$\leq$ 66VAC	$\leq$ 66VAC	$\leq$ 66VAC	$\leq$ 66VAC
Normal working current	$\leq$ 4A	$\leq$ 4A	$\leq$ 5A	$\leq$ 2A	$\leq$ 5A
Max pickup current	$\leq$ 14A	$\leq$ 14A	$\leq$ 12A	$\leq$ 9A	$\leq$ 16A
Startup accel time	3min20sec	4min30sec	6min	4min	6min
Shutdown decel time	6min	6min	8min	11min	10min
Weight	18. 5kg	18. 5kg	18. 5kg	18. 5kg	18. 5kg
Model	FD- II (B) 1200H	FD- II (B) 1300K	FD- II (B) 1600K	FD- II (B) 1800K	FD-III
Input voltage ^{Note1}	220VAC $\pm$ 10% 110VAC $\pm$ 10%	220VAC $\pm$ 10% 110VAC $\pm$ 10%	220VAC $\pm$ 10% 110VAC $\pm$ 10%	220VAC $\pm$ 10% 110VAC $\pm$ 10%	220VAC $\pm$ 10% 110VAC $\pm$ 10%
Input frequency	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)	50/60Hz ($\pm$ 5%)
Max output power	750W	750W	750W	750W	1100W
Output frequency	450 $\pm$ 10 Hz	400 $\pm$ 10 Hz	450 $\pm$ 10 Hz	450 $\pm$ 10 Hz	225 $\pm$ 10 Hz
Output voltage	$\leq$ 66VAC	$\leq$ 66VAC	$\leq$ 66VAC	$\leq$ 66VAC	$\leq$ 66VAC
Normal working current	$\leq$ 5A	$\leq$ 3A	$\leq$ 5A	$\leq$ 4A	$\leq$ 8. 5A
Max pickup current	$\leq$ 16A	$\leq$ 10A	$\leq$ 20A	$\leq$ 20A	$\leq$ 21A
Startup accel time	6min	6min	7min10sec	7min30sec	18min
Shutdown decel time	11min	11min	12min	15min	36min
Weight	18. 5kg	18. 5kg	18. 5kg	18. 5kg	27. 5kg
Startup /stop control	Controlled by keypad, external-control terminal and PC/PLC				
Display function	LCD screen displays the current output frequency, output current, current output voltage, malfunction type, and parameters for function code and operation, and model of molecular pump; two LED indicators show the power-on and malfunction status of controller.				
Protection function	Protection against under-voltage, over-voltage, over-current and over-heat for controller, protection against over-load, restricted current output, over-current and overheat of molecular pump, user's password error and external interference.				
Environment conditions	Operating environment: Free of intensely corrosive gas or dust Ambient temperature: -10 $^{\circ}$ C $\sim$ +50 $^{\circ}$ C Ambient humidity: Below 90% (no bead coagulation) Vibration strength: Below 0.5g (acceleration)				

Note 1: 110VAC and 220VAC are available for FD-II input voltage. Please specify when placing orders.

III. Installation and Wiring

3.1 Installation Environment

- Away from rain, drips, steam, dust and oil-dust; no corrosion, flammable gas, liquid; no metal particles or metal powder, etc.
- Ambient temperature: within range of -10℃~+50℃.
- Relative humidity of environment shall be lower than 90%, without any bead coagulation.
- No strong electromagnetic interference.
- Vibration strength: below 0.5g (acceleration).
- Should controller be installed inside control cabinet, sufficient ventilation shall be ensured.

Ventilation space shall be secured in the surrounding (as shown in Fig 3-1-1).

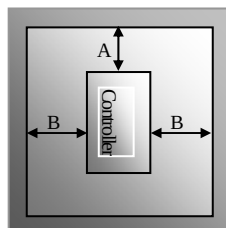


Fig 3-1-1 Controller Installation Illustration

Clearance dimensions for installation refer to below table (recommended).

Controller Type	Clearance Dimensions	
FD-I	$A \geq 150\text{mm}$	$B \geq 50\text{mm}$
FD-II (B)	$A \geq 200\text{mm}$	$B \geq 100\text{mm}$
FD-III	$A \geq 200\text{mm}$	$B \geq 150\text{mm}$

3.2 Overall Dimensions

Table 3-2 Dimensions of controller of molecular pump (Note1)

Structure code	Overall dimension (A×B×H)
C01	Under development
C02	450×220×177
C03	350×440×177
C04	262×440×177

Note 1: Please set aside at least 8mm gap at each side (left and right) of the controller when user design cabinet of controller.

3.3 Operation & Display Panel for Controller of Molecular Pump

Chinese and English are available for LCD display on display panel of molecular pump controller. Taking FD-II series for instance, and refer to Fig 3-3-1.

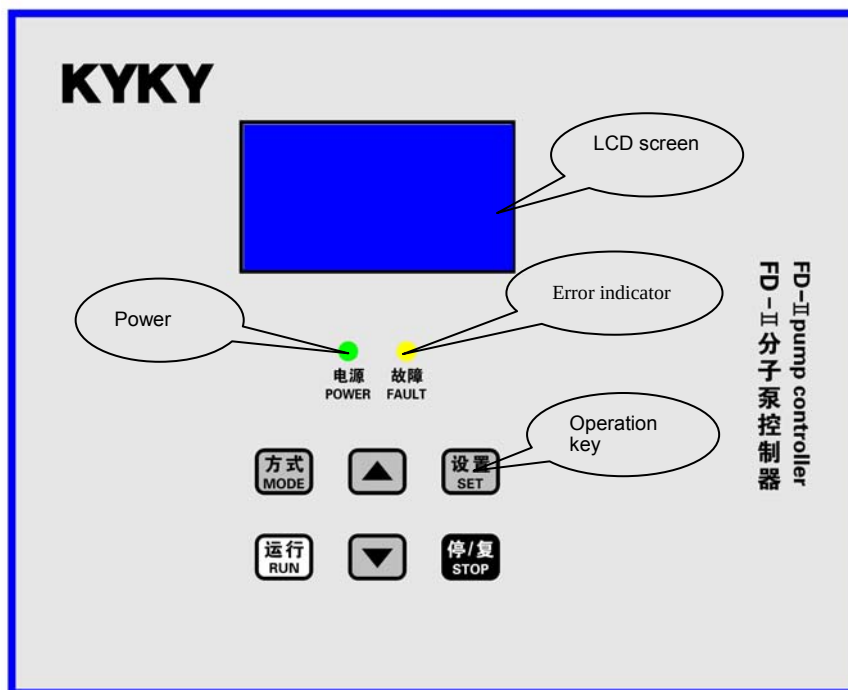


Fig 3-3-1 Diagram of Operation Display Panel

Display panel of controller for molecular pump series includes:

Display and operation zones.

Operation zone, or keypad, includes 6 function keys.

Refer to Table 3-3-2 for details and function of function keys.

Table 3-3-2 Instructions for keys on keypad

Keys	Key Name	Description
	"Mode" key	For use of maker of molecular pumps
	"Set" key	For use of maker of molecular pumps
	"Up" Key	For use of maker of molecular pumps
	"Down" Key	For use of maker of molecular pumps
	"Run" Key	CPU of starting system will start running in mode of keypad operation.
	"Stop" Key	This key is for Stop/Reset: 1): system stops and returns to standby; 2): Reset in malfunction status.

Display zone can switch the content in Chinese / English by function code 06.

In the standby status, press "mode" key, to enter the function code menu, and press "▲" key, go up to 06.

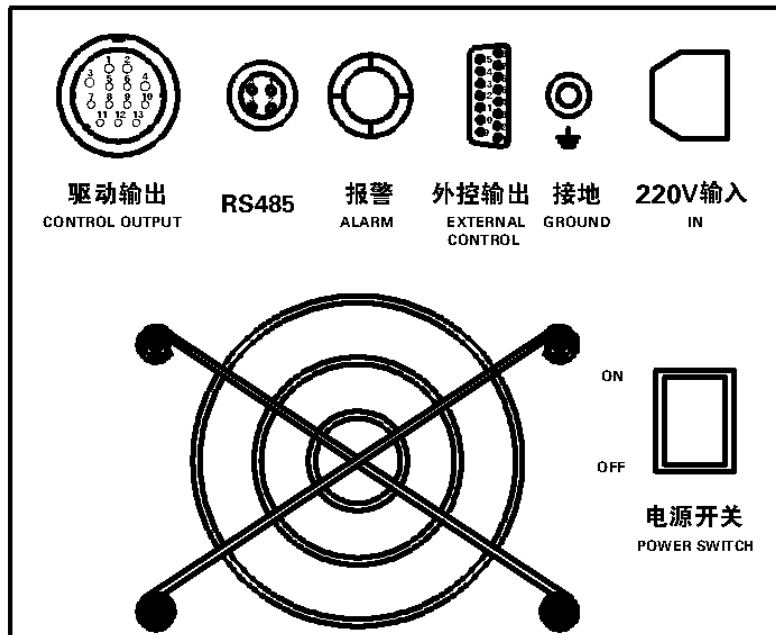
04RISE TIME
05FALL TIME
06LANGUAGE/ 语言
07GAIN PUMP TYPE

When "06LANGUAGE/语言" is in the twinkling state, press "Set" key, and enter parameters setting zone:

CHINESE/中文
ENGLISH/英文

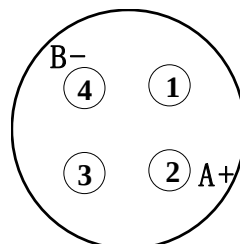
Please select needed language, let's twinkling, then press "Set" key, set successfully. And then press "function" key, return standby interface.

3.4 Diagram for rear panel of controller for molecular pump with 220V input



Function introduction of each part

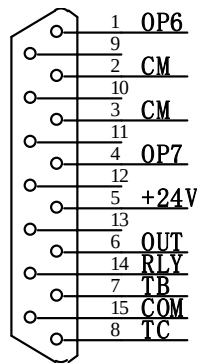
1. Power switch (POWER SWITCH): to control power connection /disconnection. As the switch is set to "ON", controller is power connected, and disconnected when switch to "OFF".
2. Input power socket (IN): 110VAC and 220VAC are available for voltage class of FD series of controller, which shall be specified when ordering. 10A/250VAC protection is built in for 220VAC input and 15A/250VAC protection for input of 110VAC.
3. Grounding terminal (GROUND): this terminal shall have to be well grounded with grounding impedance not more than $4\ \Omega$.
4. Alarm (ALARM): in case of any unexpected event with controller, this buzzer will give alarm to inform user. Check the LCD screen for specific malfunction.
5. RS485 communication connector: 485 communication control terminals A+ and B- , see the diagram below for specific pin:



PC/PLC mode may be adopted for this controller to control start, stop, observe voltage, current, frequency and to monitor malfunction status, applicable for some operations of facilities operated and controlled by computer, together with other peripheral equipment. It can find its better application for group start and group stop along production lines while individual start and stop can also be available.

Note: While controlling the running by computer through serial communication port, if the computer has an interface of RS232, converter of RS485/RS232 interface shall be used. Should the PC interface be RS485, direct wiring connection can be made.

6. External control (EXTERNAL CONTROL): this is PC jack, with signal lines for start, stop, running indicating and malfunction alarm inside. See the diagram below for specific distribution of pin definition:



Functions of each pin for external control output:

Start Mode: pins 1 and 2 are normally left in open-circuit condition of external relay (or switch). Get connected to an instant passive short-circuit signal for about 0.5S~1S when startup is intended, and molecular pump will then be started. That is, shorting pins 1 and 2 will start up the pump.

Stop Mode: pins 3 and 4 are normally left in short-circuit condition of external relay (or switch). Get connected to an instant passive open-circuit signal for about 0.5S~1S when stop is intended, and molecular pump will then be stopped. That is, disconnecting pins 3 and 4 will stop the pump.

Note: Normally closed or open contacts for a relay or those for a switch shall have to be passive. Otherwise, circuits of controller can be damaged.

Normal Output (voltage contact output signal): No voltage output for pins 5 and 6 during acceleration of molecular pump. Pins 5 and 6 will output 24VDC power signal with max current of 100mA after the pump is in normal operation.

Normal Output (no voltage contact output signal): pin 14 and 15 can provide a no voltage contact output signal. It can exert control over circuits for buzzer, lights and doors. Max permitted voltage for external power source is 24VDC while max permitted current, 0.1A. In another word, pins 14 and 15 are disconnected during acceleration of molecular pump, and connected after the pump is in normal operation.

Error Output: pins 7 and 8 can provide an error output signal (no voltage contact output signal). It can exert control over circuits for buzzer, lights and doors. Max permitted voltage for external power source is 24VDC while max permitted current, 0.1A. In another word, pins 7 and 8 are connected in case of no error with molecular pump, and disconnected when error(s) exist.

Note: an additional external control start /stop function is provided in the above-mentioned external start or stop mode on condition that function of the start /stop keys on the front panel will not be affected. When external control is not in operation, make sure to short-circuit pins 3 and 4 for external-control terminal. Otherwise, controller will not be affected by the front panel.

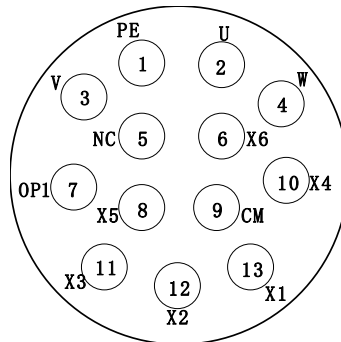
Special Startup Mode: some users need only one key or one terminal to control two statuses: open and close.

Method: short circuit pins 1 and 2 of external control to contact pins 3 and 4 to an external control switch or contact of a relay (passiveness is required). Stop happens in case of normal open while startup occurs in case of normal close. Front panel control will be invalid at this moment.

Note: Never use input voltage 110VAC or 220VAC as startup/stop input signal of controller, which will then cause damage to controller.

7. Drive output (CONTROL OUTPUT): as a 13-byte type, this connector has signal lines for auto recognition for molecule pump model, motor drive and motor overheat protection inside.

See the diagram below for specific distribution of pins:



Function of Each Pin

Pin No.	Pin Name	Function on delivered	Specifications
1	PE	Ground wire of controller	Grounding impedance not more than 4 Ω
2, 3, 4	U, V, W	Output of motor drive	Rated current 2.2
7	OP1	Signal of motor overheat	Valid for high level
9	CM	Common port of control signal	No short circuit with PE
6, 8, 10, 11, 12, 13	X6, X5, X4, X3, X2, X1	Signal of auto recognition for molecule pump model	Do not allow to connect with source signal

IV. Instructions for Application:

Taking FD-II for instance:

1. Connect the 12-core socket on molecular pump to the 13-core drive output on the controller's rear panel with a cable.
2. If user doesn't use external control function, make sure that external control plug in spare part package is well connected with external socket before power on, if use, make sure that external control plug is well connected with external socket followed by external control function instruction.
3. Turn on the power switch on controller's rear panel after well connected with power line, then controller will automatically recognize the model of molecule pump when the LCD screen of the controller shows standby status. Max working frequency of controller shall be "450.0" Hz, with flashing at the same time. Molecular pump applicable shall have a model of FF-160/620BZ.

Contents for standby interface:

KYKY		
FRQCY	:	450.0
FF-160/620BZ		
STATUSSTAY		CN/EN

4. Confirm pump model displayed in LCD. If it is the same with molecular pump model you used, press "Run" key and molecular pump will start with LCD screen showing "START TRACK".

Contents for rotate speed tracing interface:

START TRACK

5. LCD screen will then enter main interface after some time for a real-time display of the current rotate speed, frequency, voltage value, current value for molecular pump until acceleration is completed. Refer to technical performance table for the acceleration time of various controllers.

Contents for running interface:

SPEED	:	27000
FRQCY	:	450.0
VOLTAGE	:	55
CURRENT	:	5.1

6. Press “Stop/Reset” key when you want to switch off the unit. The LCD screen will now make a real-time display of the rotate speed, frequency, voltage value, current value during rotate speed slow-down until return to standby status, indicating stop is completed. Power supply switch can now be turned off. Refer to technical performance table for deceleration time of various controller.
7. If malfunction occurs to controller judgment during operation, controller shall send off sound and light warning together with character indication. Refer to fault code table. When a white alert is required, reset or turn off master power switch by pressing the “Stop/Reset” key on the keypad of controller.

Note: After fault resetting or repower on, controller will automatically recognize the model of molecule pump. Please confirm whether the displaying model is the same with the controller. If they are different, please do not run.

8. When input power failure suddenly occurs to controller, press “Run” key after power supply is resumed and LCD screen will show “START TRACK”. The LCD screen will indicate after some time the current status traced of molecular pump until reaching max working frequency.

V. Fault Code

Fault code	Types of Faults
ERR	Mal-operation with keys
OC	Over-current protection with controller
OL2	Over-current protection with pump
SL	Over-load protection with pump
OE	Over-voltage protection with controller
LU	Under-voltage protection with controller
ESP	Over-heat protection with pump
OH	Over-heat protection with controller

VI. Trouble Shooting

Errors	Causes	Actions
Connect to 110VAC or 220VAC power, open master power switch in the rear panel, but fan is not working.	Safety fuse burned inside power input socket.	Replace with new safety fuse
	Not well contacted for power input line.	Replace power input line
Turn on master switch of power to find fan working but no display with LCD	Cable not well connected or dropping out between main board of controller and LCD	Reconnect or replace cable
	Problem with LCD	Contact maker
Normal display with LCD but motor not working	Drive output connector of rear panel not well connected.	Plug connector on and off again.
	Cable broken between drive output connector and molecular pump.	Replace cable
	Motor blocked from rotating	Reduce load
	Abnormal with U, V and W output	Disconnect and reconnect power, or contact maker.

Power tripping	Short circuit with input	Check input connecting line
	Air switch capacity too small	Increase air switch capacity
	Over load	Reduce load
Not stable with motor rotate speed	Circulating water of molecular pump not through, abnormal with water pressure or water current	Check circulating water
	System leaking	Check leakage
Over-current protection with controller (OC)	Short circuit with output	Check if motor cable is broken and motor insulating grade meets requirements
	Restart the motor in rotation	Restart motor or adjust to a proper auto rotate speed tracing parameter after a complete stop of motor
Over-voltage protection with controller (OE)	Input voltage higher	Check if input voltage is normal
Under voltage protection with controller (LU)	Input voltage lower	Check if power supply is normal
	Instant power failure with input source	Normal indication
Over current protection with molecular pump (OL2)	System air-leaking with extremely low vacuum degree.	Check system equipment
Over heat protection with molecular pump (ESP)	Air leaking for a long time with system and low vacuum degree	Check system equipment
	Circulating water not turned on or water flow or pressure not sufficient.	Turn on or check circulating water
Over-load protection with pump (SL)	Pump accelerates air-leakage for mediate and long time, with over current	Check system equipment
Over heat protection with controller (OH)	Ambient temperature too high	Reduce ambient temperature
	Fan damaged	Replace fan
	Too much dirt inside controller	Clean blast inlet and outlet, and radiating fins
	Installation location not good for ventilation	Install as required in the manual to improve ventilation
	Power modular abnormal	Request maker for service

Communication error	Cable not well connected or dropping out between main board of controller and LCD	Reconnect or replace cable
Auto recognition mistake	Signal cable is not connected well	Connect the cable again
	Signal cable is damaged	Change the cable
	Affected by EMI	Eliminate the interference source, for example: relay, contactor.

KYKY MODBUS Communication Manual

(Version 1.7)

I. Modbus Overview

Modbus is a serial and asynchronous communication protocol. Modbus protocol is a general language applied to PLC and other controlling units. This protocol has defined an information structure which can be identified and used by a controlling unit regardless of whatever network they are transmitted through.

Modbus protocol does not require a special interface while a typical physical interface is RS485.

Should you need detailed information on Modbus, you may consult related books or contact us directly.

II. MODBUS Communication protocol for KYKY FD Series of Controller

1. Overall Description

- 1) Transmission mode: adopting the mode of ASCII. Two ASCII characters are required for transmitting information of 1 Byte, like transmitting 31H (hexadecimal system), '31' is expressed with ASCII code, including characters '3' and '1'. Then two ASCII characters '33' and '31' will be needed for the transmission.

Hereunder is the cross reference list for frequently used characters and ASCII code:

Character	'0'	'1'	'2'	'3'	'4'	'5'	'6'	'7'
ASCII code	30H	31H	32H	33H	34H	35H	36H	37H
Character	'8'	'9'	'A'	'B'	'C'	'D'	'E'	'F'
ASCII code	38H	39H	41H	42H	43H	44H	45H	46H

- 2) RTU mode.

In RTU mode, one Byte is expressed by hexadecimal format. For example, 31H is delivered to data packet.

2. Setting range for Baud rate: 2400, 4800, 9600, 19200, 38400

3. Frame structure

See table below:

- 1) ASCII mode

Byte	Function
1	Start Bit (Low Level)
8	Data Bit
0/1	Parity Check Bit (None for this bit in case of no checking. Otherwise 1 bit)
1/2	Stop Bit (1 bit in case of checking. Otherwise 2 bits.)

2) RTU mode

Byte	Function
1	Start Bit (Low Level)
8	Data Bit
0/1	Parity Check Bit (None for this bit in case of no checking. Otherwise 1 bit)
1/2	Stop Bit (1 bit in case of checking, otherwise 2 bits)

4. Error Check

1) ASCII mode

Longitudinal Redundancy Check (LRC): It is performed on the ASCII message field contents excluding the 'colon' character that begins the message, and excluding the CRLF pair at the end of the message.

The LRC is calculated by adding together successive 8-bit bytes of the message, discarding any carries, and then two's complementing the result.

A procedure for generating an LRC is:

1. Add all bytes in the message, excluding the starting 'colon' and ending CRLF. Add them into an 8-bit field, so that carries will be discarded.
2. Subtract the final field value from FF hex (all 1's), to produce the ones-complement.
3. Add 1 to produce the twos-complement.

2) RTU Mode

Cyclical Redundancy Check (CRC): The CRC field is two bytes, containing a 16-bit binary value.

The CRC is started by first preloading a 16-bit register to all 1's. Then a process begins of applying successive 8-bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits, and the parity bit, do not apply to the CRC.

A procedure for generating a CRC-16 is:

1. Load a 16-bit register with FFFF hex (all 1's). Call this the CRC register.
2. Exclusive OR the first 8-bit byte of the message with the high-order byte of the 16-bit CRC register, putting the result in the CRC register.
3. Shift the CRC register one bit to the right (toward the LSB), zero-filling the MSB. Extract and examine the LSB.
4. (If the LSB was 0): Repeat Step 3 (another shift).
- (If the LSB was 1): Exclusive OR the CRC register with the polynomial value A001 hex (1010 0000 0000 0001).
5. Repeat Steps 3 and 4 until 8 shifts have been performed. When this is done, a complete 8-bit byte will have been processed.

When the CRC is appended to the message, the low-order byte is appended first, followed by the high-order byte.

2. Command Type & Format

(1) The listing below shows the function codes.

Code	Name	Description
03	Read Holding Registers	Read the binary contents of holding registers in the slave.(Less than 10 registers once time)
06	Preset Single Register	Preset a value into holding register

(2) Format

1) ASCII mode

Start	Address	Function	Data				LRC check		End	
:	Controller	Function	Data	Data	...	Data	High-order	Low-order	Return	Line Feed
(0X3A)	Address	Code	Length	1	...	N	byte of	byte of	(0X0D)	(0X0A)
							LRC	LRC		

2) RTU mode

Start	Address	Function	Data	CRC check		End
T1-T2-T3-T4	Controller	Function	N	Low-order	High-order	T1-T2-T3-T4
	Address	Code	data	byte of	byte of	
				CRC	CRC	

3) Protocol Converter

It is easy to turn a RTU command into an ASCII command followed by the lists:

- 1) Use the LRC replacing the CRC.
- 2) Transform each byte in RTU command into a corresponding two byte ASCII. For example: transform 0x03 into 0x30, 0x33 (ASCII code for 0 and ASCII code for 3).
- 3) Add a 'colon' (:) character (ASCII 3A hex) at the beginning of the message.
- 4) End with a 'carriage return – line feed' (CRLF) pair (ASCII 0D and 0A hex).

So we will introduce RTU Mode in followed part. If you use ASCII mode, you can use the up lists to convert.

(3) Address and meaning

The part introduces controller running, controller status and related parameters setting.

Description of rules of function codes parameters address:

- 1) Use the function code as parameter address

High-order byte: 00 (hexadecimal)

Low-order byte: 00~63 (max range) (hexadecimal) Function code range of each partition is not the same. The specific range refers to manual.

For example:

F14 (display on the board), parameter address is 000E (hexadecimal).

F67 (display on the board), parameter address is 0043 (hexadecimal).

Note: Some function codes can only be checked but cannot be modified; some function codes can neither be checked nor be modified; some function codes can not be modified in run state; some function codes can not be modified both in stop and run state.

In case parameters of all function codes are changed, the effective range, unit and related instructions shall

refer to user manual. Otherwise, unexpected results may occur.

2) Use different parameters as parameter address

(The above address and parameters descriptions are in hexadecimal format, for example, the decimal digit 4096 is represented by hexadecimal 1000).

1. Running status parameters

Parameters Address	Parameter Description (read only)
1000	Output frequency
1001	Output voltage
1002	Output current
1003	Controller status: 00: Standby mode 01: Running 02: Mistake operation (err) 03: Over-current (OC) 04: DC over-current (OE) 05: Reserve 06: RLU 07: Over-load (OL2) 08: Power over-load (SL) 09: Molecule Pump Overheat (ESP) 0A: Under voltage (LU) 0B: Controller Overheat (OH)

2. Control commands

Parameters Address	Parameters Description (write only)
2000	Command meaning: 0003: Deceleration stop 0004: Free stop 0008: Run (no directions) 0009: Fault reset
2001	Lock parameters 0001: Relieve system locked (remote control locked) 0002: Lock remote control (any remote control commands are no valid before unlocking)

3. Illegal Response When Reading Parameters

Command Description	Function	Data
Slave parameters response	The MSB is changed into 1.	Command meaning: 0001: Illegal function code 0002: Illegal address 0003: Illegal data 0004: Slave fault

The following is response command when read/write parameters:

E.g.1: In RTU mode, change acc time (F04) to 10.0s in NO.01 Controller

Host Query

Address	Function	Register Address Hi	Register Address Lo	Preset Data Hi	Preset Data Lo	CRC Lo	CRC Hi
01	06	00	04	00	64	C9	E0

Function code F 04

Value: 10.0S

Normal Response

Address	Function	Register Address Hi	Register Address Lo	Response Data Hi	Response Data Lo	CRC Lo	CRC Hi
01	06	00	04	00	64	C9	E0

Function code F 04 Normal Response

Abnormal Response

Address	Function	Abnormal code	CRC Lo	CRC Hi
01	86	04	43	A3

The MSB of function code is 1. Slave fault

E.g. 2: Read output frequency, output voltage, output current and state of controller from N0.2 controller.

Host Query

Address	Function	First Register Address Hi	First Register Address Lo	Register count Hi	Register count LO	CRC Lo	CRC Hi
02	03	10	00	00	04	40	FA

Communication Parameters Address 1000H

Slave Response:

Address	Function	Byte Count	Data Hi	Data Lo	Data Hi	Data Lo	Data Hi	Data Lo	Data Hi	Data Lo	Crc Lo	Crc Hi
02	03	08	13	88	00	39	00	3C	00	01	4E	4B

Output Frequency Output Voltage Output Current Running

NO.2 Controller's output frequency is 50.00Hz, output voltage is 57V, output current is 6.0A

E.g. 3: NO.1 Controller is running.

Host Query:

Address	Function	Register Hi	Register Lo	Write status Hi	Write status Lo	CRC Lo	CRC Hi
01	06	20	00	00	01	43	CA

Communication parameters address 2000H Running

Slave Normal Response:

Address	Function	Register Hi	Register Lo	Write status Hi	Write status Lo	CRC Lo	CRC Hi
01	06	20	00	00	01	43	CA

Normal Response

Slave Abnormal Response:

Address	Function	Abnormal Code	CRC Lo	CRC Hi
01	86	01	83	A0

The MSB of function code is 1. Illegal function code (assumption)

E.g. 4: Read the value of 04, 05 from NO.2 controller

Host Query:

Address	Function	Register Address Hi	Register Address Lo	Register Count Hi	Register Count Lo	CRC Lo	CRC Hi
02	03	01	0D	00	02	85	F9

Communication Parameter Address Quantity of Read Registers

Slave Normal Response:

Address	Function	Byte count	The first parameters status Hi	The first parameters status Lo	The second parameters status Hi	The second parameters status Lo	CRC Lo	CRC Hi
02	03	04	03	E8	00	78	49	61

The actual value is 100.00.

The actual value is 12.00.

Slave Abnormal Response:

Address	Function Code	Abnormal Code	CRC Lo	CRC Hi
02	83	04	B0	F3

The MSB of function code is 1.

Controller fault

3. Additional Remarks

Expressions during communication course:

Parameter Values of Frequency=actual value $\times$ 10

Parameter Values of Time=actual value $\times$ 10

Parameter Values of Current=actual value $\times$ 10

Parameter Values of Voltage=actual value $\times$ 1

Parameter Values of Power=actual value $\times$ 100

Parameter Values of Version No. =actual value $\times$ 100

Instruction: Parameter value is the value sent in the data package. Actual value is the actual value of controller.

After PC/PLC receives the parameter value, it will divide the corresponding coefficient to get the actual value.

NOTE: Take no account of radix point of the data in the data package when PC/PLC transmits command to controller. The valid value is range from 0 to 65535.

III Function Codes Related to Communication

Function Code	Function Definition	Setting Rang	Mfr's Value
70	Controller Address	1~247	1
71	Parity Check Selection	0: No checkout 1: Odd 2: Even	0
72	Baud Rate	0: 2400 1: 4800 2: 9600 3: 19200 4: 38400	3
76	Modbus mode selection	0: ASCII mode 1: RTU mode	0

You can read device status, function codes value, "write" control command and "write" function operation preset functions value regardless of control mode.

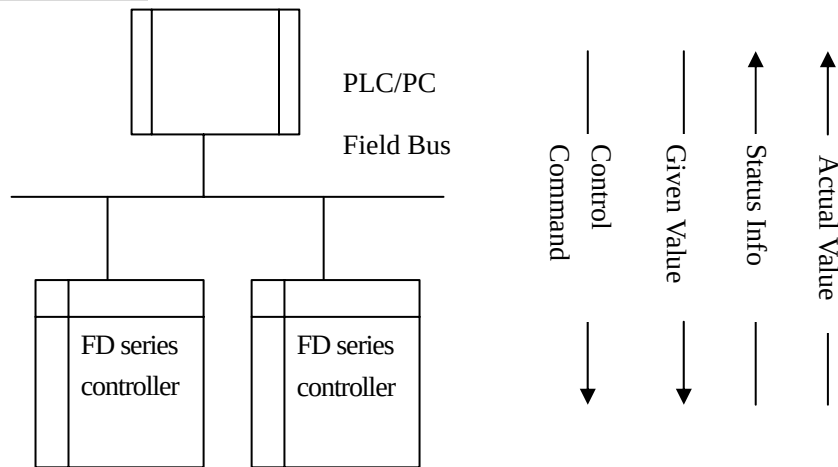
Please set functions code related to communication consonant with the PLC/PC communication parameters, when controller communicates with PLC/PC.

IV Physical Interface

1. Interface instruction

Communication interface of RS485 is located on the rear panel of controller, marked underneath with A+ and B-.

2. Structure of Field Bus



Connecting Diagram of Field Bus

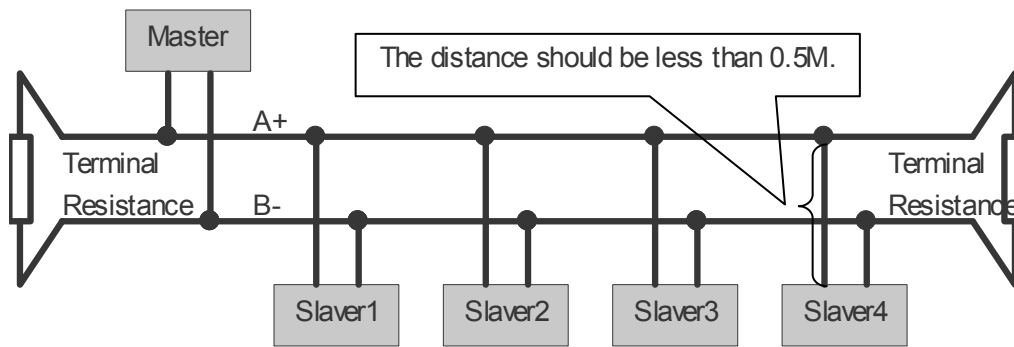
RS485 Half-duplex communication mode is adopted for molecule pump controller. Daisy chain structure is adopted by 485 Bus-line. Do not use 'spur' lines or a star configuration. Reflect signals which are produced by spur lines or star configuration will interfere in 485 communications.

Please note that for the same time in half-duplex connection, only one controller can have communication with PC/PLC. Should two or more than two controllers upload data at the same time, then bus competition will occur, which will not only lead to communication failure, but higher current to certain elements as well.

3. Grounding and Terminal

Terminal resistance of 120Ω will be adopted for terminal of RS485 network, to diminish the reflection of signals. Terminal resistance shall not be used for intermediate network.

No direct grounding shall be allowed for any point of RS485 network. All the equipment in the network shall be well grounded via their own grounding terminal. Please note that grounding wires will not form closed loop in any case.



Connecting Diagram of Terminal Resistance

Please think over the drive capacity of PC/PLC and the distance between PC/PLC and controller when wiring. Add a repeaters if drive capacity is not enough.



All wiring connections for installation shall have to be made when the controller is disconnected from power supply.

成套仪器：

序号	名 称	单位	数量	备注
1	分子泵控制器	台	1	
2	电源线	根	1	标准长 2.5 米
3	驱动输出电缆线	根	1	标准长 2.5 米 注：非标准线长可向厂家咨询定制
4	10A 保险丝（输入电压 220VAC）	个	2	FD-II，FD-IIB 配备
	15A 保险丝（输入电压 110VAC）	个	2	FD-II，FD-IIB 配备
	15A 保险丝（输入电压 220VAC）	个	2	FD-III 配备
	20A 保险丝（输入电压 110VAC）	个	2	FD-III 配备
5	补板	块	2	FD-II 配备 FD-IIB、FD-III 无配备
6	衬条	个	1	
7	把手	个	2	
8	RS485 通讯插头	个	1	
9	外控插头	个	1	
10	使用说明书	份	1	
11	检验合格证	张	1	

Instrument in Complete Sets:

No.	Description	Unit	Q'ty	Remarks
1	Molecular pump controller	set	1	
2	Power line	piece	1	Standard length 2.5m
3	Cable for driver output	piece	1	Standard length 2.5m Note: Non-standard cable can be consulted to the maker.
4	10A Fuse (input voltage 220VAC)	piece	2	FD-II, FD-IIB equip
	15A Fuse (input voltage 110VAC)	piece	2	FD-II, FD-IIB equip
	15A Fuse (input voltage 220VAC)	piece	2	FD-III equip
	20A Fuse (input voltage 110VAC)	piece	2	FD-III equip
5	Complementary plate	piece	2	FD-II equip FD-IIB、FD-III no equip
6	Backs	piece	1	
7	Handles	piece	2	
8	RS485 Communication plug	piece	1	
9	External control plug	piece	1	
10	Instruction Manual	set	1	
11	Quality Inspection Certificate	page	1	

保 修 说 明

凡购买我公司生产的分子泵控制器，从购机日起凭保修单可保修一年。

外地用户可延长一个月，在保修期内不收修理费，如需要更换零件，一般核收半费，不超过半年可免费。

凡属下列之一的不予保修：

- 1、用户对产品私自拆卸。
- 2、用户保管或使用不当（如撞击）。
- 3、属于用户其他原因造成的损失。

Warranty

Any controller of molecular pump purchased from us shall be entitled to a one- year warranty period against warranty certificate, effective from purchase date.

Users beyond maker's location shall have his warranty period extended by one month. No repair expense shall be charged during warranty period. Should there be any part to be replaced, charges shall be reduced by half in a normal case. Free of charge shall be offered in case of not exceeding six months.

Any of the followings shall not be covered under our warranty:

1. Dismantling the product by users without permission.
2. Improper storage or application by user (like striking /knocking).
3. Loss resulting from other causes by the user.

09032409

产品保修单

产品名称: FD 系列分子泵控制器

产品编号: _____

用户单位: _____

[illegible]

.....剪开.....盖章处.....

以下请用户详细填写并寄回我公司以备查询

产品型号/名称: FD 系列分子泵控制器

联系人: _____

产品编号: _____

联系电话: _____

购机日期: _____

邮政编码: _____

单位地址: _____

单位名称: _____

Warranty Certificate

Product Name: FD series controller for Molecular Pump

Product Code: _____

User: _____

Date	Repairing & Maintenance	Handled by

.....Cut from here.....For Seal

Please complete the following in details and return to us for file.

Product Model/Name: FD Series Controller For Molecular Pump Contact:_____

Product Code: _____ Tel: _____

Purchasing Date: _____ Zip: _____

Unit Address: _____

Unit Name: _____