WEBTEC®

HYDRAULIC MEASUREMENT AND CONTROL

HPCM2

Inline Contamination Monitor

在线污染监测仪

www.webtec.com

产品介绍

HPCM 可测量和量化液压、润滑和传动系统中固体污染物的数量。HPCM2 以矿物油作为工作液，测量精确，一经安装，永久使用。

该装置符合国际标准 ISO 4406:1999、NAS 1638、AS 4059E/F 和 ISO 11218。

HPCM 集成了一个可接入电源和 PLC 的设备连接器，能够进行 RS485、CANBUS 或 4-20mA 信号传输。HPCM 还提供了一个单独的连接器，利用 RS485 或 USB:RS485 接口同时进行计算机远程监控或设置访问。

内置的数据记录器可存储多达 4000 次的测试结果，便于无法持续连接计算机的应用场合。

提供简单的开关量输入和报警输出，作为控制设备和输出结果的替代方式。前面板的“全彩”指示灯可指示清洁度。

该仪器采用光消原理，利用特别校准的精密 LED 光源透射液体，照射在光电二极管上。当粒子通过光束时，就会减少二极管接收的光量，根据这种状态的变化，可以推断出粒子的大小。

优势

- 实时测量
- 灵活切换手动、自动和远程控制
- 湿度和温度感应
- 彩色 LCD 和 LED，清晰直观地显示故障和报警。
- 带 USB 的型号可下载即时结果

产品特点

湿度传感器

HPCM2 模块使用电容式相对湿度（RH）传感器测量含水量。结果用饱和度百分比表示。100%RH 对应于流体中自由水出现的状态，即流体无法将水保持在溶解的溶液中。该点通常也是液压系统损坏的发生点，因此相对湿度是一个理想的测量刻度，与流体特性无关。

产品概述

水饱和点(100% RH)与温度有关，所以要同时测量温度。这样才可对结果进行有意义的比较。

测量的温度是指通过装置的流体温度。请注意，根据流速、管道长度和环境温度的不同，这个温度可能与液压系统的温度有差异。它并非为了准确地显示系统温度，而是为测量相对湿度提供参考。经验表明，在大多数应用场合，测量的温度与液压系统的温度误差在几度之内。

数据记录器

HPCM 包含一个内置的数据记录器，即使未连接到计算机，它也可以在内部存储器中进行本地记录，并记录时间戳测试结果。

- 测试记录需要进行设置
- 每个记录条目都有时间标记，并包含 HPCM 序列号，以便日后查阅。
- HPCM 内存可容纳约 4000 条日志记录。内存不足时，最早的记录会被覆盖。

关于如何通过定制的 windows 版软件下载测试记录，请参阅 5.3.1 和 5.3.2 节。

通过 **USB** 传输数据

HPCM2 可以通过 USB 盘 直接下载。HPCM 通电后，将 U 盘插入装置顶部的 USB 接口。

测试结果写入 U 盘时，屏幕/指示灯将短暂地变成黄色。完成写入后，将变成绿色，此时可拔出 U 盘。如果数据传输出现问题（U 盘已满或损坏或未被识别），则屏幕/指示灯将变成红色。发生这种情况，操作者可以取下 U 盘，然后用另一个 U 盘再试一次。

本装置提供的 USB 盘已预先格式化,方便传输。其他的 U 盘可能需要重新格式化（FAT32）。

请注意： USB 选项只能用于下载测试结果。任何其他用途都可能导致装置损坏。

免责声明：

持续改进是我们的一贯的策略，威泰科保留更改技术规格的权利，恕不另行通知。

目录

本指南涵盖以下内容

本指南将带您了解 HPCM 2.0 的安装和使用。

本指南信息详尽，使您能够掌握设备的全部功能，以及有关安全、保修、维护和附件的关键信息。

如果您有任何疑问或问题，请到第 10 节故障诊断和报告中获取更多信息。

操作指南

1 一般警告和终端用户信息

1.1 一般安全警告

在阅读本手册之前，请勿操作、维护或执行任何程序。操作本装置的人都应穿戴下列个人防护设备。

防护眼镜
- 安全鞋
- 手套
- 防护服（或其他合适的防护性衣物）

在执行机器安装程序和/或使用前，应严格遵守本手册的说明。此外，还必须遵守现行的职业事故预防和工作场所安全的法规。

在本文件中，下述突出的标志是为了预防操作人员健康危害，含义如下：

警告 	是指与产品、产品使用相关的重要信息或本文件中必须特别注意的地方。

小心 	意味着不遵守相关安全规定，可能会造成轻度伤害或财产损失。

危险 	意思是说，如果不遵守相关的安全规定，可能会导致死亡、重伤或严重的财产损失。

意思是不遵守相关安全规定，可能会导致死亡、重伤或严重的财产损失。

一般性警告

操作员	操作员的任务是在生产过程中使用本设备。操作者了解设备制造商为消除工作场所的潜在危险源而采取的全部措施，并考虑到操作上的限制。
参与吊装/ 起吊作业的人员：	指安置设备或设备部件的人。参与吊装和起吊作业的人员了解安全转移设备或设备部件的规定，因此，他们按照产品制造商提供的说明，使用适当的提升设备。
设备调试员	其任务是调试机器，使其运行。机器调试工了解为消除工作场所的危险源而采取的措施，并考虑操作上的限制。机器调试员采取一切适当的预防措施，在最安全的条件下操作。
维修技术员	指其负责机器维护活动的人。维修技术员了解可能出现的危险情况，并采取相应的预防措施，以消除工作场的事故风险。
电工	负责电气线路维护工作的人。电工了解可能出现的危险情况，并采取适当的预防措施，以消除工作场所的事故风险。

1.3 操作人员位置和危险区域

本装置不需要操作人员。但是，以下区域被认为是危险区域。靠近电动机的地方，因为运行设备可能表面发热。

警告 	本装置应按照运行所在国家的现行规定停用和/或拆除。

小心 	装置不宜在室外使用，所有电气设备的防护等级必须达到 IP55 及以上。

1.4 无法消除的危险和危害

- 电动机有触电危险；电机故障时
- 高温带来烧伤风险
- 意外漏油带来滑倒危险。
- 软管断裂，导致润滑剂流失

当油温超过40/45 °C时，在处理金属枪/软管和移动装置时必须非常小心。避免与热油和过滤器本体直接接触。

设备使用后，必须先冷却再搬运。

1.5 个人防护装备

操作时，人员必须穿戴安全鞋、手套、护目镜。一般来说，根据所要执行的操作，按下表选择 PPE。



操作	PPE
普通作业	鞋子、手套、护目镜、防护服
有计划的维修	鞋子、手套、护目镜、防护服

一般性警告

2 运输和存储

2.1 运输和处理条件

该装置用聚氨酯泡沫包裹，装在一个纸盒中运输。

HPCM 及附件的包装重量为 2.5kg。

2.2 存储

设备不用时，应存放在远离生产区的适当位置。设备存放时应将端口盖好。所放置的位置不应妨碍其他生产活动或人员。

交通/存储

3 保修、限制和免责声明

威泰科保证其生产和销售的产品自发货之日起 12 个月内不发生材料、工艺和性能上的缺陷。

硬件/固件

如果硬件在保修期内出现缺陷，威泰科将自行决定修理缺陷产品或更换同等产品，不收取零件、人工、运输和保险费用。

软件

威泰科保证自发货之日起 12 个月内，软件将基本按照其功能规格运行，前提条件是操作环境的完整性没有因误用、不适当的处理、不正常的操作条件、疏忽或损坏（有意或无意）或引入与威泰科产品有任何冲突的第三方产品（软件或硬件）而受到影响。

资格认定

本质保仅适用于原购买者或威泰科授权关联公司的终端用户。

如何获得服务？

若要获得本保修条款下的服务，客户必须在保修期满前通知 Webtec，并按照威泰科品退货政策退货。任何返修的产品必须附有一份完整的故障报告，说明故障发生的现象和条件。如果客户因未能完成适文书工作而导致威泰科产生额外费用，那么客户可能会被收取管理费。

不适用

本保修书不适用于因使用不当或保养不当而造成的任何缺陷、故障或损坏。在以下情况下，威泰科将免除保修义务：

(a) 初次收到产品时，没有对产品进行全面和适当的检查(未按照装运时随附的文件所要求的那样)而造成损坏。

(b) 威泰科官方工作人员之外的个人试图修理或维护产品造成的损坏。

(c) 因使用不当或与连接不兼容的设备或产品（包括软件应用程序）而造成的损坏。

4.技术规格

4.1 性能

技术方面	基于 LED 消光自动光学污染监测器
粒子大小	>4、6、14、21、25、38、50、70µm。
分析范围	ISO 4406: 代码 0 至 25 NAS 1638 00 至 12 级 AS4059 Rev E 表 1 和 2 尺寸 A-F:000 请注意：(下限取决于测试时间) 如果系统清洁度预计高于 22/21/18 或接近 NAS 12。
校准	每台设备依据 ISO 11171 的 ISO MTD 粉尘（MTD）标准, 在 I.F.T.S.认证的设备上进行校准。ISO 11943
湿度和温度测量	% 饱和度 (RH) 和流体温度 (°C) - 仅限矿物油/柴油版产品。
精度	±½ ISO代码：4, 6, 14µm ±1个代码：21、25、38、50、70µm ±3°C ±3% RH

技术规格

4.2 电气接口

额定电压	9-36V DC			
额定电流	12V 150mA 70mA	24V 80mA 40mA	36V 60mA 30mA	 K 型 NON-K 版本
消耗功率	最大2.2W			
测试时间	10-3600 秒可调（出厂设置为 120 秒）。			
数据存储	HPCM 内存记录约 4000 次有时间戳的测试结果。			
键盘和 LCD	6 个按键，128x64 像素，背光图形显示。			
通信方式	RS485 MODBUS CANBUS 4-20 mA			

4.3 外形特征

尺寸	123 毫米(高)x142 毫米(宽)x 65 毫米(深)
安装	2 个孔，直径 7mm，间距 126mm
重量	1.6kg
连接方式	G1 M16x2 液压连接 G3 ¼" BSPP 母型端口 G4 7/16 UNF 母型端口
密封材料	M/N 版本--FKM（与 FKM 密封不兼容的流体请联系威泰科。）

4.4 流体特性

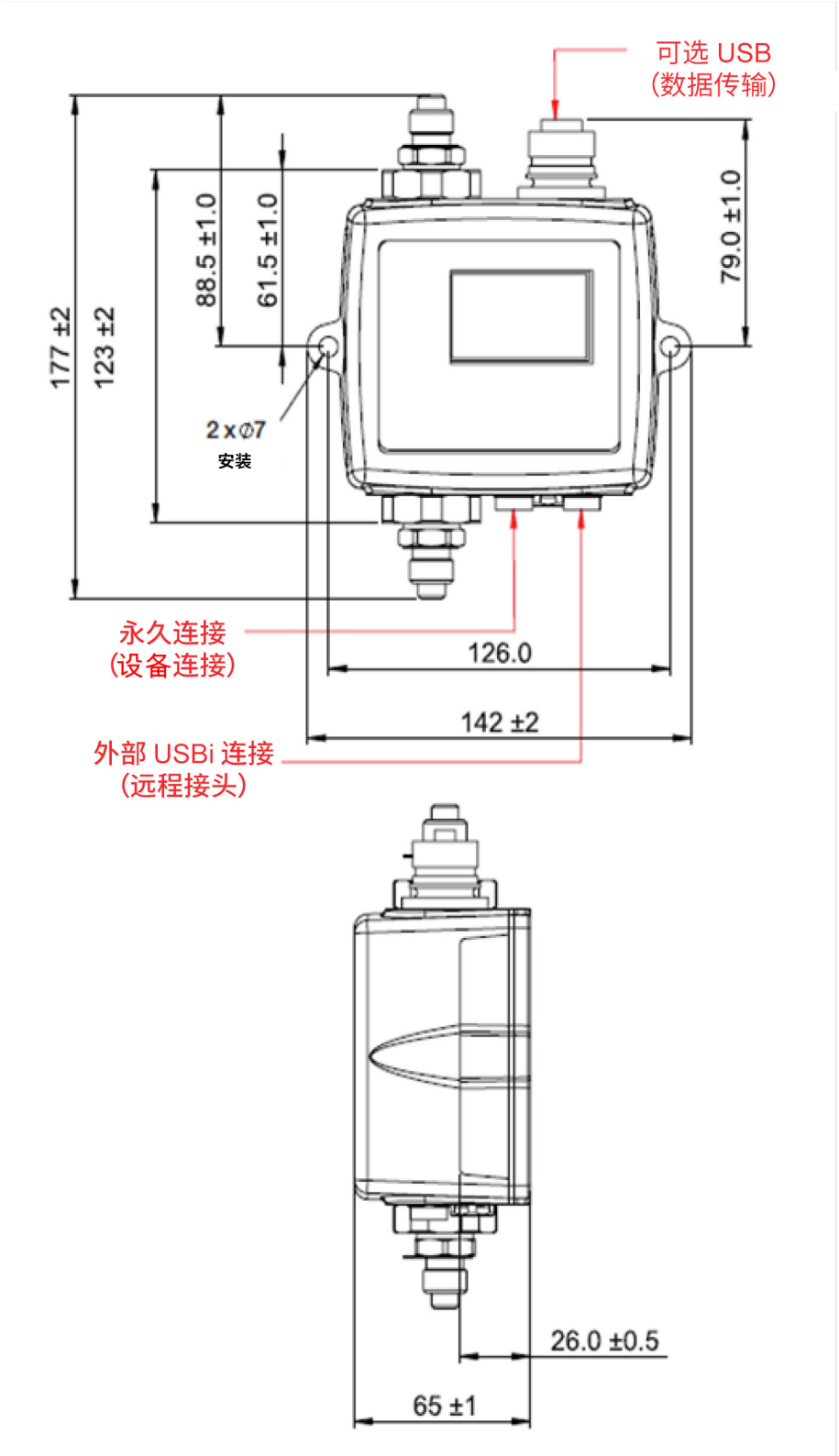
流体兼容性	M型 - 矿物油、合成润滑油和柴油。
粘度	≤1000 cSt
流体温度	-25°C 至 +80°C
工作流量	20-400 毫升/分钟
最大压力	静态 420 Barg（应用于高频压力脉冲时，请联系威泰科。）
压差	通常为 0.5bar

4.5 环境

工作环境温度	-25°C 至 80°C 非 K 型/-25°C至55°C K 型。
IP等级	IP66
IK等级	IK04

技术规格

尺寸（毫米）


可选 USB
(数据传输)
79.0 ±1.0
88.5 ±1.0
61.5 ±1.0
177 ±2
123 ±2
2 x ⌀7
安装
永久连接
(设备连接)
126.0
142 ±2
外部 USBi 连接
(远程接头)
26.0 ±0.5
65 ±1

4.6 接液部件清单

M版
铜合金 C46400
不锈钢
Sapphire (Al_2O_3)
FKM
PTFE
FR4

技术规格

5.产品安装及一般操作

5.1 安装

每台 HPCM 都包括以下内容。
- HPCM
- 校准证书
- U盘，内含：产品用户指南、LPA-View 软件、附件驱动程序和产品手册。
- 预制的 3 米电缆
- 快速入门指南

可选装置：
- HPCMUSBi USB 适配器，带预 接线 的 HPCM 电缆。

5.1.1 实物安装

- 设置液压回路中的分接点
- 设定好位置，利用固定孔将本装置固定在所需位置。HPCM 必须垂直安装，油流向上。
- 线路回接至接线盒
- 检查流量是否在可接受范围内。流过 HPCM 的压差必须大于 0.5bar，这样才能在设备量程范围内产生流体流动。
- 如果没有合适的压差，则需要使用流量控制器。控制器应该安装在 HPCM 的排水侧（顶部接头）。
- 机械固定
- 连接系统中的软管或硬管
    - 排水管中不能有额外的限流装置。不要利用限流器来控制任何一根管道的流量。此类限制器必须直接安装在 HPCM 排水管接头上。(A)
    - 流体必须从底部接头流向顶部，遵循产品标签上的流动方向箭头，即底部接头为入口，顶部接头为出口。
- 安装电气接线端子，将导线接至接线盒。

(A) 这是因为在 HPCM 和下游限流器之间的管道不论长短如何，都可能成为蓄流器。HPCM 进口中的任何压力脉动（例如来自泵的压力脉动）都会转化为流量的脉动，有时会导致流量随脉动实时逆转。如果流量很低，这可能会使同一粒子前后扫视多次，混淆结果。

5.1.2 电气接口

单独的 HPCM-USBi 附件为客户提供便捷的即插即用解决方案，使 HPCM 连接至计算机。本节是为那些希望自行为产品布线的用户编写的。

5.1.2.1 电气连接器

HPCM 有两个圆形连接器，位于设备的下表面。根据安装和配置情况，USBi 可以连接其中的一个。

PIN	颜色	“设备”连接器	“远程”连接器
1	黄色	RS485+/CANL/4-20mA(A)	RS485+
2	粉色	开始输入	
3	绿色	RS485-/CANH/4-20mA(B)	RS485-
4	白色	输出 1	
5	灰色	I/O 公共端	
6	棕色	输出 2	
7	蓝色	DC 0V	DC 0V
8	红色	DC+电源	DC+电源

5.1.2.1.1 远程连接器

“远程连接器”用于临时连接外部通信设备，如 HPCMUSBi，可用以下载数据、远程控制或使用 LPA-View 软件进行诊断。
这是离液压接口最远的圆形连接器。

它可以传输 RS485 数据，也可以在系统关闭无法给装置提供电源时，临时给设备供电。

该连接器不发送报警信号。若需通过 USBI 发送报警信号，则必须将其连接至机器连接器。

5.1.2.1.2 机器连接器

“机器连接器”连接至为 HPCM 供电的PLC/机器。它具备电源接口、一个启动信号输入、两个继电器输出和一个数据接口，可以设置为 RS485、CANbus 或 4-20mA 信号模式。

这是最靠近液压连接头的圆形连接器。

注：若设置为 CANBUS 或 4-20mA 选项，则无法在该端口使用 RS485 适配器（如 USBI）。如果需要临时接入设备，应使用右侧端口（远程连接器）。

注：只有该连接器可以接入启动信号，提供继电器输出。

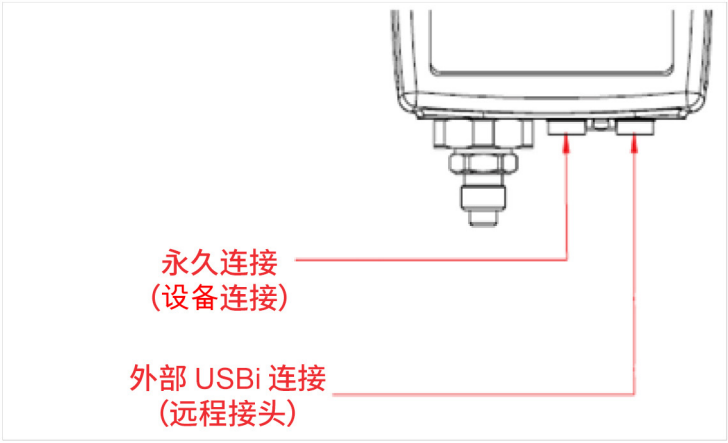


图5.1 连接器方向

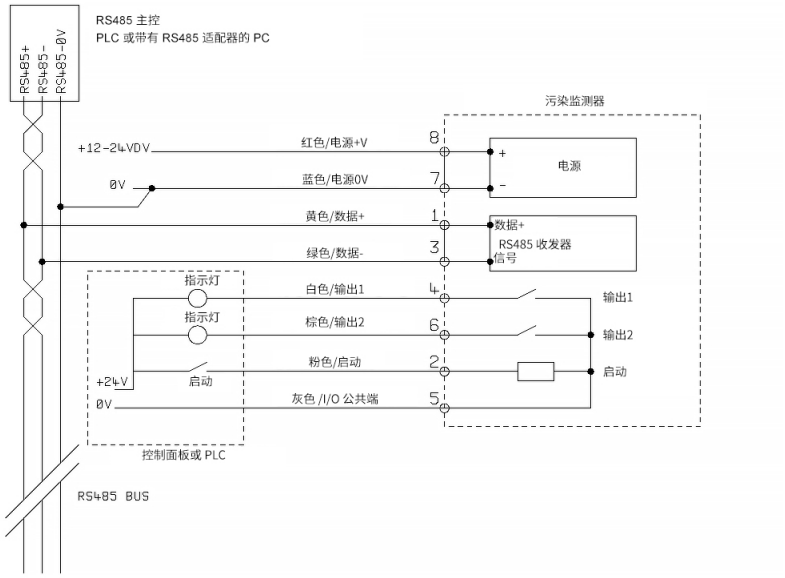


图5.2 机器连接器外部接线示例

5.1.2.2 直流电源

直流电源接入任一圆形连接器的7和8针脚（如果使用预制电缆，则为红色和蓝色）。其他信号可依据需要接入。

项目	最低	最高
电压	9v DC	36V DC
电流		200mA

5.1.2.3 机器连接器 - 串行接口

RS485 或 CAN 总线接口可连接至引脚1和3（黄色和绿色）。可以接入一个运行客户程序的PLC，或者一台带有 RS485 适配器运行 LPA-View 的计算机。RS485 0V 应与 HPCM 0V 接在一起，提供电平参考。

HPCM 的标准控制协议是 Modbus RTU。Modbus 是一个免费开放的工业控制标准。适配器可连接其他工业控制总线。威泰科自有的 LPA-View 软件通过 Modbus 协议与 HPCM 通信，但客户也可以部署自己的控制器（Modbus 分站）。

也可以使用 CANbus 协议，见 5.4.2 节。

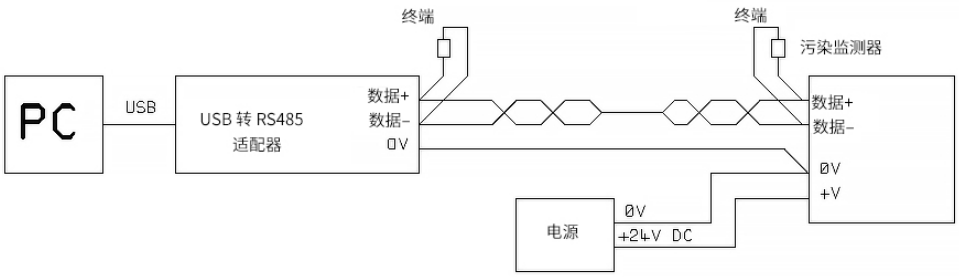


图5.3a 计算机控制实例

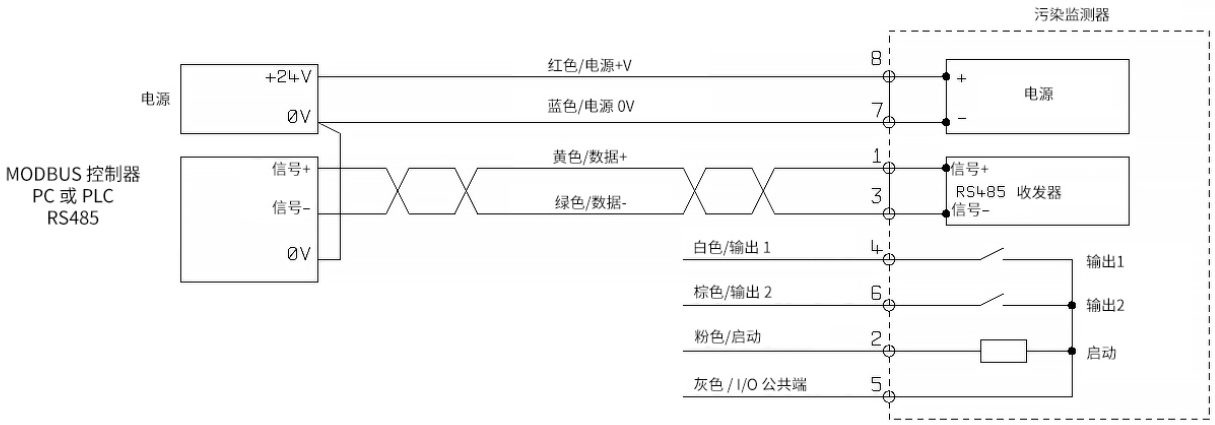


图 5.3b Modbus 控制器示例

图 5.3a 显示 USB-RS485 适配器将单台 HPCM 连接至计算机。图5.3b 展示了一种稍微不同的方法。对于长电缆，例如超过 10 米的电缆，应按图所示安装 100 欧姆的终端电阻。超过 2 米的电缆应使用双绞线。

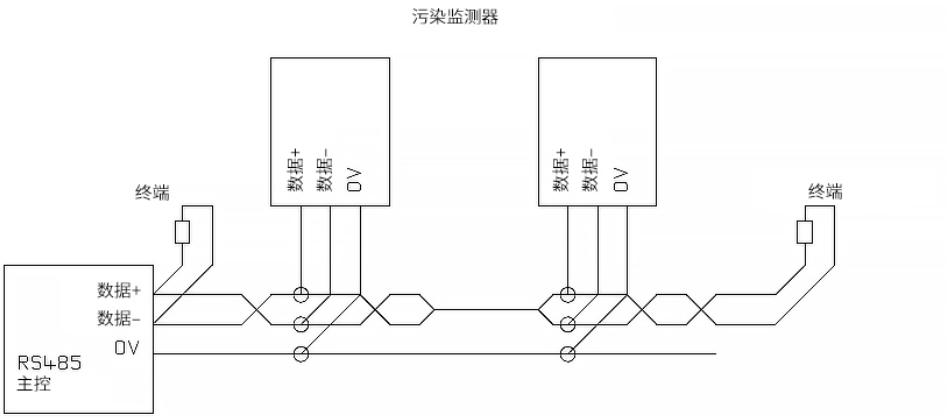


图5.4 多点网络示例

图5.4 显示如何将两台或多台 HPCM 装置连接到一个多点 RS485 网络。终端电阻应只安装在网络电缆的末端。RS485 主线的分支线应尽可能短，即小于 2 米。通常 HPCM 可选用 3 米长的预制电缆，通过接线盒连接到 RS485 主干线。既可以使用单独的直流电源为每个 HPCM 供电，也可以使用单电源通过主干电缆供电。

5.1.2.4 开关量输入和输出信号

HPCM 有一个开关量输入和两个开关量输出。它们可以代替或补充 RS485 接口，用于命令和控制。RS485 接口更灵活，但如果不使用 LPA-View，可能需要更多的软件编程工作（例如由 PLC 进行控制）。另一种选择利用PLC 或 手动开关和指示灯通过 I/O 接口控制 HPCM。

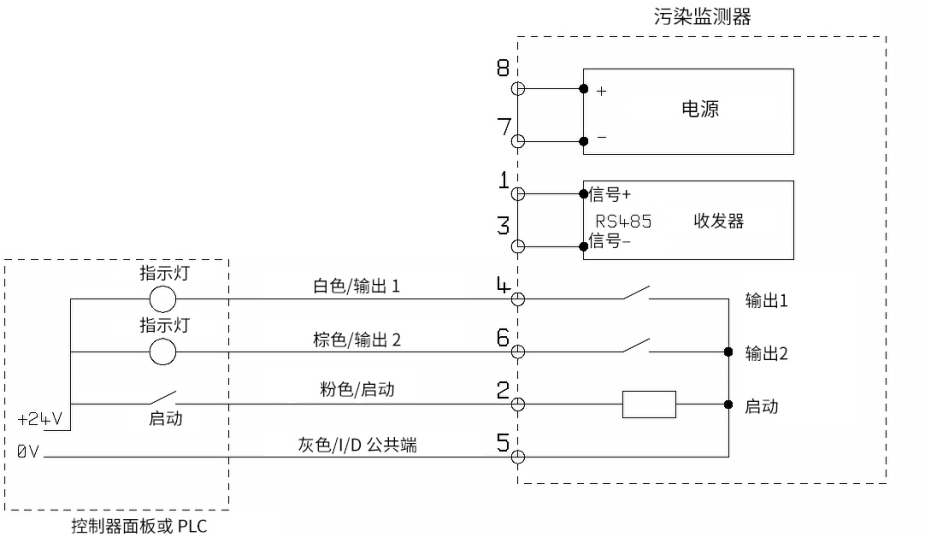


图5.6 开关量 I/O 信号

为了减少接线，输入和输出在一侧端接在一起（见图 5.6）。但它们与系统的其他部分是光隔离的，因此可以用来切换多种信号。

5.1.2.5 启动信号

“启动信号”是一个光隔离输入，用以启动测试，它确保测试只在液压系统运行时进行。例如，可以将“启动信号”端子的接通与关断与主液压泵或允许液体流动的电磁阀关联在一起。这样一来，记录中就不会出现无流量情况下进行的无效测试。

启动信号可以来自一个按钮或 PLC 输出。该输入端可接入交流或直流信号，通常接入直流电源电压。该输入的具体功能由测试模式决定，参见 8.1.1.3节。

项目	最低	最高
电压	9V DC	36V DC
阻抗	10K 欧姆	

- 当“启动信号”从 OFF 转为 ON 时，装置将开始一个新的测试或重新开始正在进行的测试。
- 在测试结束时，检查启动信号的状态。
- 如果测试结束时启动信号仍然有效，则开始新一次测试。这样，启动信号保持接通的情况下，测试会继续进行。
- 启动信号的关闭作为停止命令。也就是说，它将中止任何正在进行的测试。装置将继续显示和报告先前的结果。
- 无论是否启用连续测试，这种新的操作模式会起作用。
- 例如，如果“连续测试”和“洁净时停止测试”两个功能都被启动，并且在整个测试过程中保持启动信号，那么无论是启动信号的消失还是得到洁净结果，测试都会终止。

- 这与“启动信号分隔测试”选项（以启动信号定义测试持续时间”）不是一回事。该选项的功能是利用启动信号来控制*单次测试*的持续时间

其他的测试方式有

- 通过HPCM前面板上的开始按钮（K键盘选项）。
- 通过 LPA-View 或 PLC 的 Modbus 命令。
- 根据编程的测试模式进行定期自动测试。

5.1.2.6 报警输出

这些是光隔离开关量，可向外部指示器、PLC 输入或其他设备（如泵的开/关控制）发出信号。

这些输出的具体功能取决于报警模式的设置。
输出为“无源”触点，可切换标称值高达 36V 的 AC 或 DC 信号（最大绝对峰值电压 60V）。

项目	最低	最高
电压		36V DC
电流		0.5A

5.1.2.7 4-20mA 接线

两个4-20mA 输出从直流主电源取电。这些输出可连接到过程指示器或 PLC 的 4-20mA 输入端。0V 端通常连接到 PLC 的0V。

每个 4-20mA 输出和 0V 之间下拉一个 250 欧姆的电阻就以转换为 0-5V 输出。同样，也可以通过下拉 500 欧姆的电阻转换成 0-10V 输出。

有关 4-20mA 信号如何对应测试结果的细节，请参见 5.4.3 节。

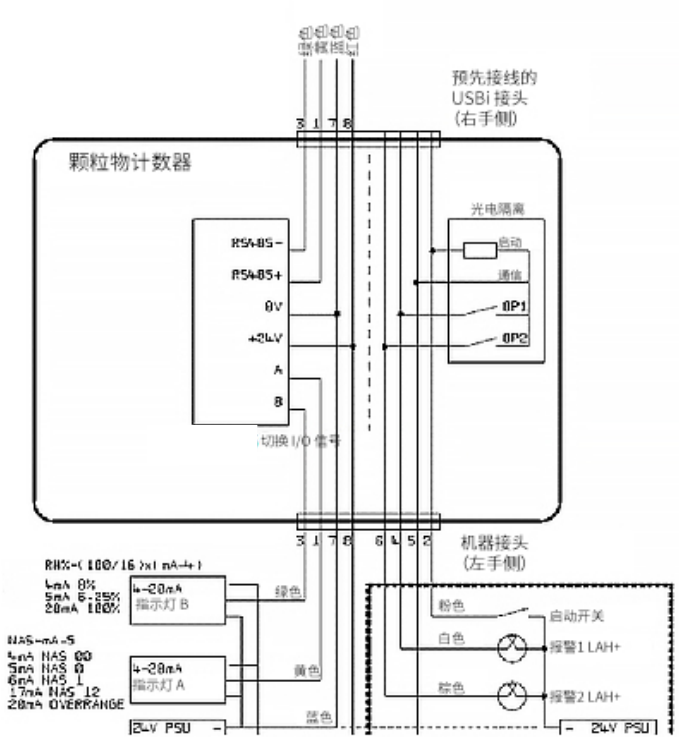


图5.7 开关量 I/O 信号

5.1.3 液压连接

1 高压或低压串联

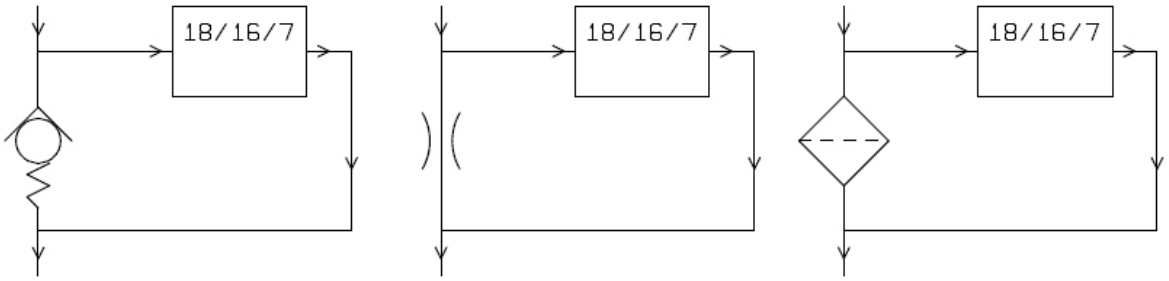


图 5.8 HPCM 工作压力由液压元件产生

2 低压、离线操作

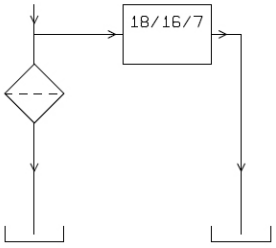


图 5.9 HPCM 工作压力
由液压元件产生

3 极低流量系统

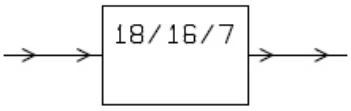


图 5.10 整个系统流量在 HPCM 的量程范围内

5.1.3.1 流速

对于大多数系统来说，几个 Bar 的压差就能使两根 1.5 米长的微孔压力管连接的 HPCM 产生一个量程内的流量。所需的压差可利用系统内现有的压降。另外，还可以通过插入一个止回阀来创造一个压差。然后将 HPCM 连接到这个压差源上。

5.1.3.1.1 详细计算

一般情况下，通过 HPCM 的流量需要在设备允许的范围内（见液压规格）。HPCM 在运行过程中测量流量，可以用来检查流量是否正确。
如果流量超出量程，则会有故障代码提示。
注：超出范围的流量结果不作记录。

流量产生于连接 HPCM 的管道两端之间的压差。先确定目标流量，接着确定横跨 HPCM 和连接管道的压降，就可估算出产生量程范围内流量所需的压力。利用图 5.11 查询 HPCM 的压降，从生产厂家的数据查询目标流量下的管道压降。这两个压力之和就是所需压力。

用户将 HPCM 连接在液压回路中具有此压力差的两点之间。
为了使用该图。

- 确定流体的工作粘度，如 30cSt。
- 确定一个所需的流量。通常使用 200ml/分钟，这是 HPCM 流量范围的中间值。不过 100ml/分钟也比较恰当，而且耗油量较少。
- 使用图5.11 查找该流量和粘度下 HPCM 端口的压降。如：在 30cSt 和 200ml/分钟 时，压降为 0.4 Bar。也可分别用 400ml/分钟 和 20ml/分钟 的两条线确定最大和最小允许差压。

- 确定连接 HPCM 的管道所造成的额外压降。对于 1/4 英寸及以上的管道来说，这一点可能可以忽略不计，但对于微孔软管来说却非常重要。这些信息可以在制造商的产品目录里查到。使用微孔软管时，当工作粘度为 30cSt 时，每米每升每分钟流量的压降约为 10 Bar。因此，总长度为 2 米的软管将增加 2×10×0.2=4 Bar 的压降。所以在这种情况下，压力-流量关系主要取决于软管阻力）。

- 将 HPCM 的压降与软管的压降相加，即 4+0.4=4.4 Bar。

确定了所需的压降后；

- 请参阅本节开头的图表，了解 HPCM 可以连接的点。

- 如果液压回路中有一对连接点，其工作压差接近于计算出的压差，那么 HPCM 可以连接在那里。

- 或者，通过修改液压系统来产生压降。例如，在回路中插入一个带有 4 bar 弹簧的单向阀。这个 “部件”也可以是过滤器、限流器，甚至是一段管道，只要其压降恰当即可。

- 如果这些方案都不可行，则可能需要一个主动流量控制器。

- 否则，将 HPCM 连接到所确定的点上；注意保持油液向上流过设备（这样可减少残留的空气）。

- 当然在实际系统中，压力和粘度会随着温度和工作条件的变化而变化。但由于 HPCM 的 流量量程非常大，只要保持在范围内，应该不会有问题。在图上，上下线之间的区域代表了 HPCM 的可用工作区域，中间线是理想的状态。只要系统保持在上下线范围内，压差和粘度可以与理想值不同。这样可以保证流量维持在 20-400ml/min 的工作范围内。由此可见，该装置在运行过程中可以适应粘度或压差 20:1 的变化。

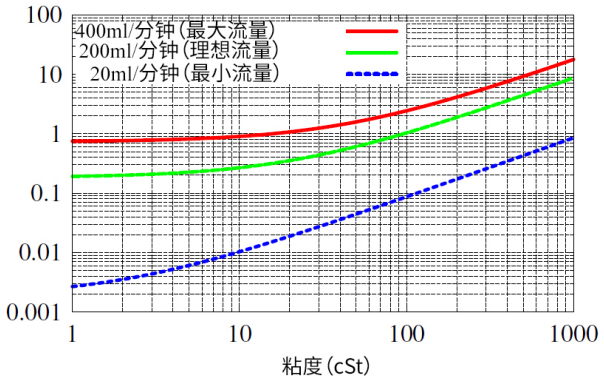


图 5.11 不同流量下的压差与流体粘度的比较

5.1.3.2 手动流量控制

另一种办法是在 HPCM 的出口安装一个简单的手动流量控制（流量限制器）。

- 只有在可用压力低于最大计算值的两倍时，才可以这样做。这是因为控制大于此压力的流量所需的孔径较小，有堵塞的危险。
- 流量控制器必须只安装在出口处，如果安装在进口处，则有过滤作用。如果安装在入口处，则会产生过滤作用。
- 流量控制器必须直接安装在 HPCM 出口端口。

5.2 一般操作

5.2.1 实物检查

- 设备上及周围漏油
- 软管和管道的脆弱点在系统压力下可能会发生泄漏。

5.2.2 前面板操作

5.2.2.1 状态 LED

HPCM2 各个版本的前面板上都有一个多色指示灯，用于指示状态或报警状态。HPCM2 还有一个可变色的屏幕。可以通过串行接口在 LPA-View 中设置报警阈值。

图5.13 K 版产品的前面板

颜色	指示
绿色	表示测试结果已通过，即没有超阈值报警。
黄色	表示超过了下限清洁度，但没有超过上限清洁度。
红色	表示超过了上限清洁度。
蓝色	表示超过了含水量上限。
红/蓝交替	表示清洁度和含水量均超标上限值。
紫色	表示超过了温度上限。
红白光闪烁	不同的故障代码可表现为 LED 灯变成红色，然后多次闪现白色。

请注意：虽然这些代码看起来很混乱，请注意，只有当用户设置相应的阈值时，才会看到特定的颜色。
例如，如果没有设置最高温度限制，则永远不会看到紫色指示。如果只需要“绿灯或红灯”，只需设置清洁度阈值上限即可。

如果设置了温度上限报警，其优先级高于污染和水含量报警。当出现超温状况时，无论是否还有污染或
水含量报警，LED 都只会变成紫色。这样设置的原因在于，超温条件可能会立即给液压系统带来灾难性的后果。

5.2.2.2 前面板操作

5.2.2.2.1 结果显示

HPCM-K 配有 6 按钮的键盘和一个小的图形化 LCD。它可以显示测试结果（当前的清洁度等级，含水量和温度（如有））。

图形化的格式可以完整显示所有支持的标准代码。

装置开机后进入“显示模式”。以选定的格式显示测试结果。下表显示了可用的格式。

右边一栏的截图是“详细”版的显示，额外显示了粒子数和流量。颗粒大小和计数方式自动与选定的格式相匹配。

还有一个“历史（History）”页面，显示最近 10 个结果。
操作者可使用 v 和 ∧ 键在这些屏幕间切换。

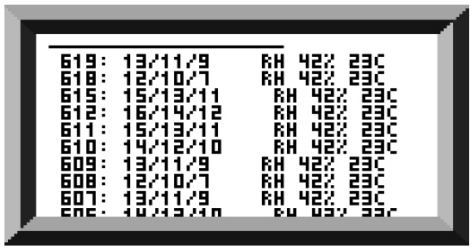


图 5.14 历史画面

测试的进度用水平条表示；随着测试的进行，水平线从左到右增长。到达右侧时，就会产生一个新的结果。

5.2.2.2.2 诊断显示

按 < 或 > t，显示图 5.15 所示的诊断显示（诊断问题时使用）。然后使用 v 和 ^ 按钮在诊断屏幕之间切换。

“完成”（Completion）显示一个从 0 到 1000 的数字，表示测试进度。
FLOW ml/min 提供流量的近似值，在每次测试后更新。

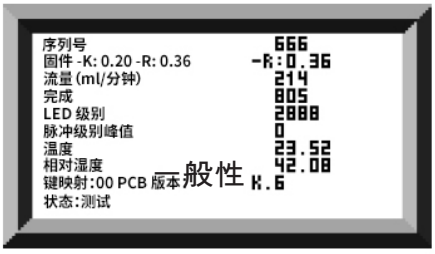
注：这不是一个校准的流量计，仅用于指示。

然而在安装设备或检查操作时，可以确保流量在装置的量程范围内。其他项目主要用于协助报告问题。

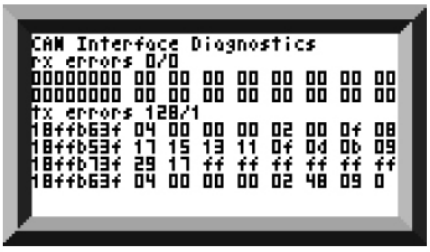
“状态”（STATUS）行显示装置的当前状态。任何错误，如流量过低，也会出现在这里（对应于前面板 LED 故障代码）。

第二个屏幕显示 Modbus 串行通信流量的相关诊断数据。外部通信错误是指计算机和 HPCM 之间的错误。内部通信错误是装置的内部错误，表示 HPCM 键盘/显示电路板与传感器本身之间的通信错误。

第三个屏幕显示 CAN 总线通信有关的诊断信息。更多详情，请参考单独的 HPCM CAN 总线手册。还有一个“历史（History）”页面，显示最近 10 个结果。操作者可以使用 ^ 和 v 键 在这些屏幕之间切换。



Modbus



CAN 总线

图5.15 诊断屏幕

5.2.3 HPCM 拆除和产品维护。

当从系统中拆除 HPCM 时，要确保系 HPCM 已断开系统压力。

- 如果不能解决问题，则尝试使用异丙醇或石油醚，按标准方向和反向流动方向进行冲洗。
- 如果这不能解决问题，则送至威泰科进行检查。

5.3 HPCM 控制

HPCM 可以通过计算机端的 LPA-View 软件包中的远程控制功能进行控制。客户也可以使用自己的计算机软件。
由于 HPCM 内置了数据记录存储器，操作者可以通过两种方式使用远程控制功能。

—直接在线操作
在进行测试时，HPCM 与计算机保持长久连接。操作者可以设置参数，输入标签并启动测试。他们可以监控每次测试的进度。每个测试结果都会显示，并在完成后下载到测试数据库中。

—离线操作
HPCM 作为一个独立运行的装置，按计划或根据控制系统的外部指令实施测试。如果需要对结果进行永久记录，操作人员可以连接计算机，使用 LPA-View 下载累积的测试数据。HPCM 的内存中最多可以容纳 4000 次测试结果。

5.3.1 计算机连接

计算机或控制设备可用 RS485 适配器进行连接。

HPCMUSBi 是（所有现代笔记本电脑和及试验机）的预接线版的 USB。进行连接，启动 LPA-View，然后给 HPCM 供电。

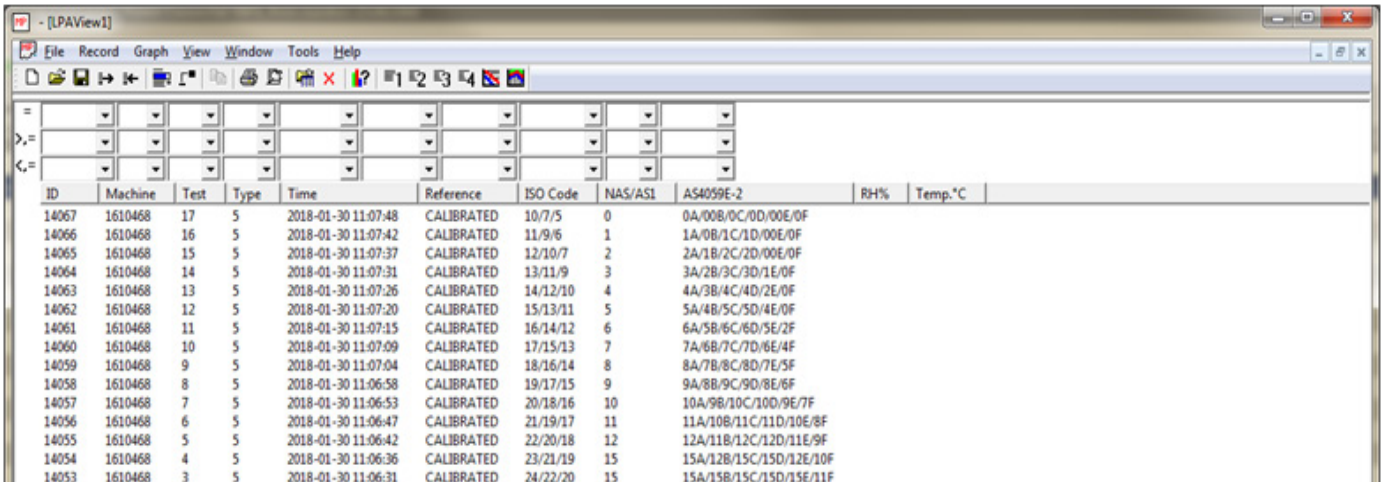


图 5.16

要在 LPA 视图中访问远程设备设施，请按工具栏上的远程控制按钮（图 5.17）。然后会出现连接对话框
（图 5.18）。

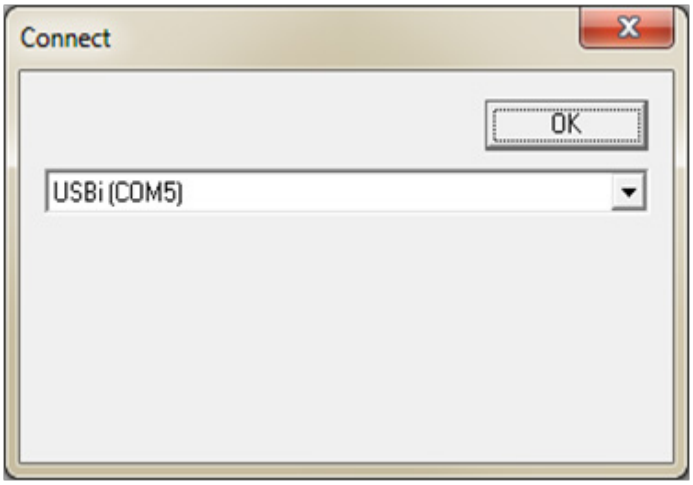


图 5.18

第一次执行此操作时，必须正确选择计算机上的通信端口（COM 端口），详情如下。

程序会扫描计算机上的可用端口，并将它们放在一个列表中供用户选择--这个列表在“连接”按钮上方的方框中。按此框右侧的箭头，选择计算机上的连接。

计算机的所有工作通讯端口都可以选择。选择用于连接 HPCM 端口，然后按“确定”。如果您不确定哪个端口是正确的，COM 端口号旁边会显示设备名称。通信建立成功后，将出现远程控制对话框。连接成功后，COM 端口将被记住，以便下次使用，并在对话框中作为默认的 COM 端口出现。如果没有出现 COM 端口，请参考手册中的故障查找部分。

5.3.2 计算机软件操作

远程控制对话框允许操作人员使用 LPA-View 在笔记本电脑上手动控制 HPCM。它还可以用来下载自动（断开）运行时积累的测试结果。

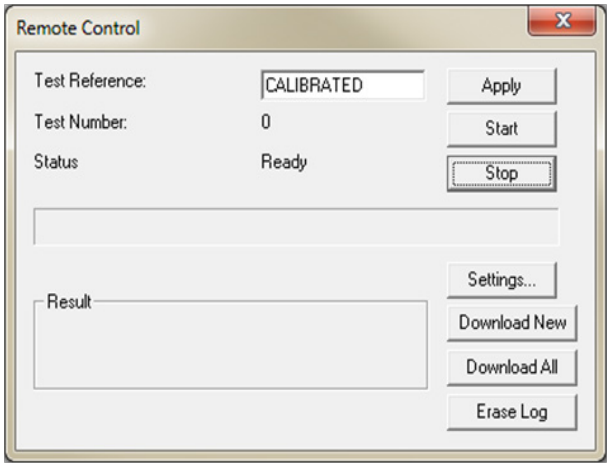


图 5.19

要执行一项测试，首先要有选择地编辑“测试参考值（Test Reference）”，然后按“应用”按钮注册新值。这是一个描述性的标签，可以用来识别测试或对测试分组（连同测试编号和测试时间/日期）。例如，机器编号或客户名称。“测试参考值”的长度可以达到 15 个字符。

连接后，HPCM 状态应显示“（准备好）Ready”。然后，操作者可以按“开始（Start）”按钮开始测试。进度条显示测试进度。
可以在任何时候按“停止（Stop）”按钮放弃测试。如果在测试过程中按下“开始”按钮，则会放弃当前的测试并开始新的测试。当测试结束后，“结果（Result）”区将以设定的格式显示污染程度、水含量和温度（如果适用）。
测试结束后，测试编号会自动递增，并显示测试状态。如果状态为 Ready，那么操作者可以再次按下“开始（Start）”按钮，开始新的测试。
也可以配置一段延迟时间，然后自动开始另一个测试。在这种情况下，状态会变为“测试中（Testing）”或
“等待中（Waiting）”。

HPCM 内置一个数据记录器，因此可以使用“下载新的结果（Download New ）”和“全部下载（Download All）”按钮将以前的测试结果下载到测试数据库中。这两个按钮的区别是，“下载新的结果”按钮只传输以前从未下载过的结果。“全部下载”则传输所有存储在 HPCM 中的结果。“清除记录（Erase Log）”删除 HPCM 内存中的测试结果。
当用户完成 HPCM 操作后，可以使用关闭控件（对话框右上角的 “X”）或按 Esc 键关闭对话框。按“设置...（Settings...）”按钮可弹出远程装置设置对话框。

5.3 3 设置

可以使用远程装置设置对话框重新配置 HPCM。通常是在安装或调试过程中完成。

进行任何更改后，按“确定”按钮更新 HPCM 的设置。或者按“取消（Cancel）”键，保持设置不变。

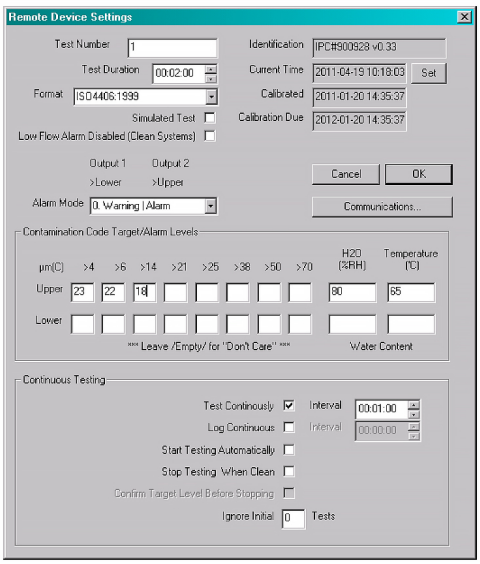


图 5.20

注：HPCM 设计灵活，因此有广泛的设置和操作模式。不过，出厂默认值适合大多数应用，许多用户可以跳过本节。即便初始配置为高级设置，实际操作也很简单。

注：根据 HPCM 配备的选项，可能会缺少一些项目。

5.3.3.1 概述

可提供 HPCM 装置的一般信息。显示 HPCM 序列号和软件版本。序号与测试时间戳是测试记录的唯一标识。这两个参数是用来避免测试重复记录。

“当前时间 (Current Time)”显示 HPCM 上设置的时间。这一点很重要，因为这是测试的时间戳。按 “设置 (Set)”按钮会自动将 HPCM 时间与计算机上的时间同步。

校准区域显示上次校准的日期和下一次校准日。

5.3.3.2 测试编号

“测试编号(Test Number)”用来识别系列测试中的某一次测试。不过，HPCM 启动时，“测试编号”会自动重置，所以最好使用时间戳（测试日期和时间）和测试参考。

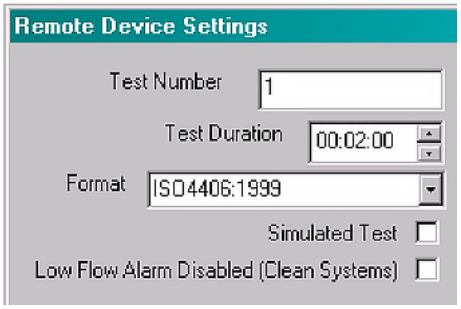


图 5.21

注意：如果任何时候对 HPCM 重新通电，则测试编号序列会自动重置并重新开始。

5.3.3.3 测试时间

测试的长度由“测试持续时间(Test Duration)”控制。
出厂设定的 2 分钟值适合大多数应用，但用户可以自由设定不同的值。设置较短的时间可使 HPCM 对污染水平的短期波动反应更灵敏。由于计数的粒子数量存在统计波动，因此对于大粒径和清洁系统，结果会不一致。

较长的测试时间将在非常干净的系统中和大粒径下提供更“稳定”的结果，因为在测试期间计数的颗粒总数较大。这意味着任何波动对测试结果的影响较小。

5.3.3.4 结果显示

利用选择器选择首选的显示格式（ISO、NAS等）。这个选择不仅仅是表面上的，因为它还决定了如果使用清洁度报警目标，如何解释这些目标。

5.3.3.5 模拟测试

当没有可用流量但需要测试通信时，可以使用此设置。

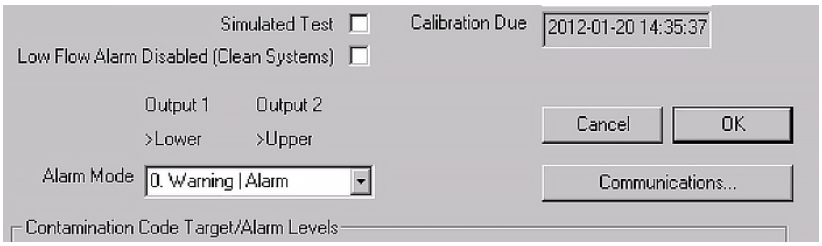


图 5.22

5.3.3.6 禁用低流量报警（清洁系统）。

值得强调的是，该产品的主要功能是测量清洁度，而不是充当流量计。如果装置进行污染测量，则流量就要满足污染测量的要求。

HPCM 需要通过流通池的颗粒物来计算流量，系统越脏，流量输出的统计精度就越高。

反之，当放置在一个非常干净的系统中时，由于通过流通池的颗粒数量非常少，本装置可能难以计算出流量。为了克服这个问题，测试必须满足一定的条件，才能得出有效的结果。

如果低流量报警已被禁用，那么在测试过程中必须有至少 20 个大于 4 微米的颗粒出现，流量读数才会显示，测试结果才会有效。

如果在测试过程中未出现 20 个大于 4 微米的颗粒，那么即使低流量报警已被禁用，HPCM也会报警/显示故障代码。

注意：如果已禁用低流量警报，则最好以这样的方式安装 HPCM：如果系统关闭（零流量），则也关闭 HPCM，以免测量积液并提供错误的读数。

如果过滤量低于 10um（ISO 14/12/10（NAS 4级）），可能需要关闭低流量指示器，位置见图 5.22。

5.3.3.7 连续测试

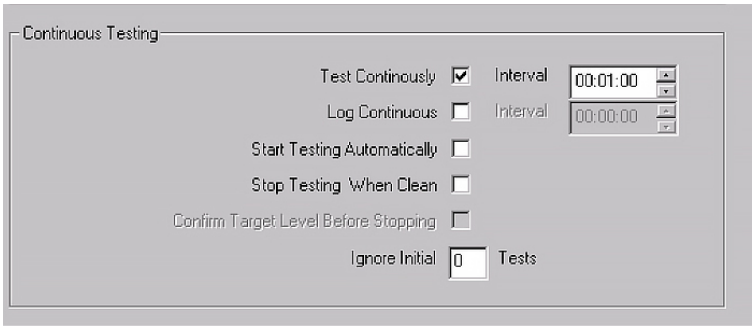


图5.23

在“连续测试(Continuous Testing)”区域中，有一些设置可控制 HPCM 何时执行和记录测试。选择“连续测试”后，HPCM 根据指定的测试间隔自动重复测试。

1. 设置一个比测试持续时间长的时间间隔，就可在该时间间隔结束后重复测试。例如，设定测试持续时间为 1 分钟，测试间隔为 10 分钟，结果是每 10 分钟进行一次 1 分钟的测试。测试时间是间隔时间的一部分
2. 将间隔时间设置为小于测试持续时间的值（例如零），那么在一个测试结束后立即开始一个新的测试。

“连续记录(Log Continuous)”决定是否记录连续测试期间的结果。这是为了避免测试记录混淆大量不需要的测试结果。如果不选择“连续记录(Log Continuous)”，则只记录一系列测试里的最后一次测试（请参见下面的 “报警模式 ”和 “清洁时停止测试”章节 ）。

如果选择连续记录，那么可以设置记录间隔来控制测试实际被记录的比例。例如，HPCM 可以设置为每 10 分钟测试一次，但每小时只记录一次结果。记录间隔、测试间隔和测试持续时间是不同的参数，它们共同控制测试和数据的记录。用户可以单独设置 2 分钟的测试持续时间、10 分钟的测试间隔和 1 小时的记录间隔。这样就会出现 2 分钟长的测试，每 10 分钟重复一次，每小时记录一次。
注意：记录间隔必须落在测试间隔上，否则会出现错误，例如测试间隔是 2 分钟，记录间隔却是 3 分钟。

清洁时停止测试—该功能适用于清洁设备或 “滤油车”类型的应用场景。HPCM 继续测试，直到液体变“干净”为止。这时装置发出报警信号，停止测试。

忽略初始测试—装置启动时，根据选择的数字，前几次的测试结果不被记录。这是为启动时特别脏或湍流的系统设计的，可使系统稳定下来再记录结果。

在停止前确认目标水平—确保测试序列不会过早终止，因为系统中仍有一些大颗粒。选择该选项后，方框中的数字表示测试停止前需要多少个连续的“清洁”结果。

* 此功能适用于“滤油车”类型的应用，在这种应用中，系统里的泵运行至油品充分清洁为止。通常情况下，只有最终的“清洁”结果需要记录。

5.3.3.8 更改通信协议

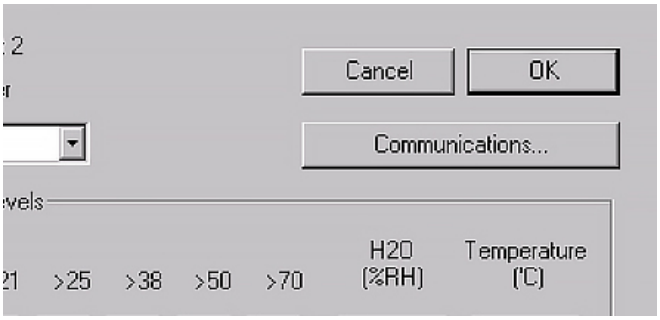


图 5.24

设置通信按钮可以改变 HPCM 的通信方式。参见图 5.25 的选项。

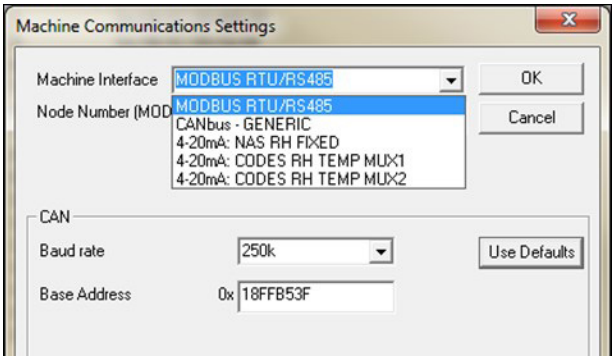


图 5.25

选择机器接口，设置机器连接器的输出类型，例如选择 CAN 总线就意味着不能再利用机器连接器进行 Modbus 通信（默认）。如果你想改回去或改成 4-20mA 的通讯方式，那么你必须通过远程连接器连接至 HPCM。

5.3.3.9 报警

HPCM 有两个开关量的“报警”输出，可以根据测试结果和报警设置，以各种方式向外部设备发出信号。还有一个多色的前面板指示灯，显示测试结果与设定的报警阈值的对比情况。

报警设置全面而灵活，拓展了 HPCM 的应用场景。

5.3.3.9.1 报警级别

报警阈值可在对话框的污染代码目标/报警级别区域中设置。
报警可以设置为清洁度代码、水含量和温度的组合。可用的代码及其含义根据设定的测试格式而不同。例如，可以设置“NAS 11”或“ISO 18/16/15”或“AS4059E 8B-F”等格式的报警阈值。

一般来说，清洁度等级有上下限，如果适用，还可以设置含水量和温度的阈值。启用后，如果超过上/下限制，警报将被激活。但如果某个字段未填写（空白），则默认为“不关注”。

如果 4μm 计数大于 ISO 代码 23，或 6μm 大于 ISO 代码 22，或 14μm计数大于代码18，或含水量大于 80% Rh，或温度大于 65°C，则达到上位报警。由于所有的下位设置都是空的，所以永远不会触发下位报警。

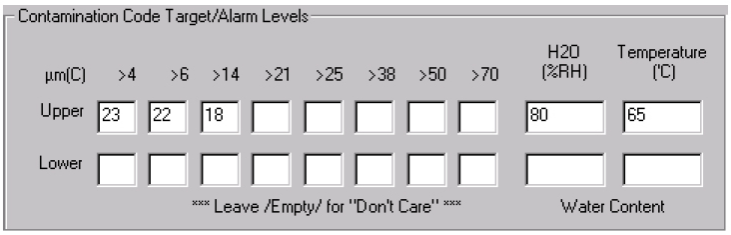


图 5.26

ISO4406:1999 报警级别

ISO4406:1999 以大于 4、6 和 14µm 的颗粒数的代码来表示清洁度。选择 ISO4406:1999 测试格式，然后按要求输入数值，这些代码就可以作为报警的限值。作为 ISO4406:1999 的延伸功能，也可以指定其他颗粒尺寸的代码。如果不需要，可以留空。

NAS1638 报警等级

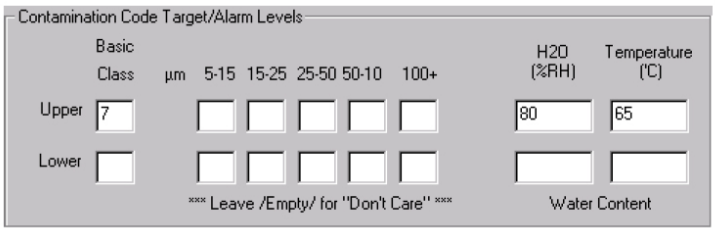


图 5.27

NAS1638 可以用作测试格式，用来设置的标题和方框会适当改变。NAS1638 用单个代码表示整体清洁度，污染度按各尺寸段中最高等级来定。因此，我们可以对整体污染等级（基本等级）进行限制，也可以对定义的粒度范围内的等级组合进行单独限制。

AS4059E 表 **2** 报警级别

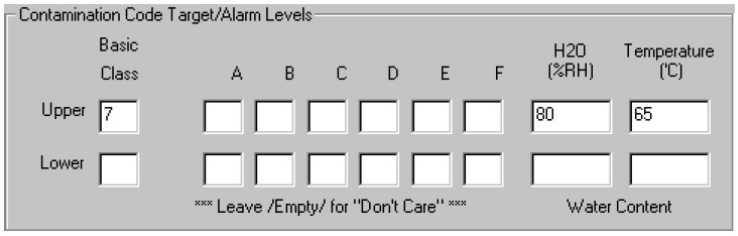


图 5.28

AS4059E 表 2 使用字母而不是数字来表示粒径范围，因此对设置进行了适当的标记。标准规定了只使用可用粒度的子集来表示清洁度等级，例如 B-F。用户只需对目标粒度进行设置，其他则留空。因此，AS4059 7B-F的限值可以简单地将 B、C、D、E和F的值设置为7。

AS4059E表1/ISO11218 报警级别

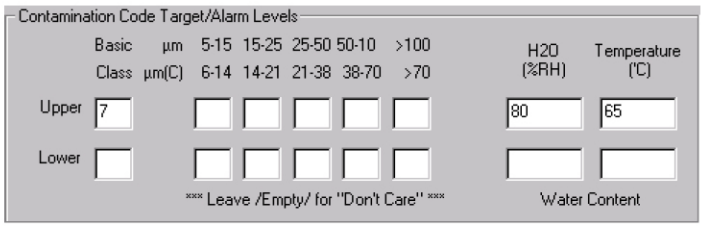


图 5.29

除了术语和报告格式外，这两个标准是相似的。实际数字大小和各类别阈值相同。

5.3.3.9.2 报警模式

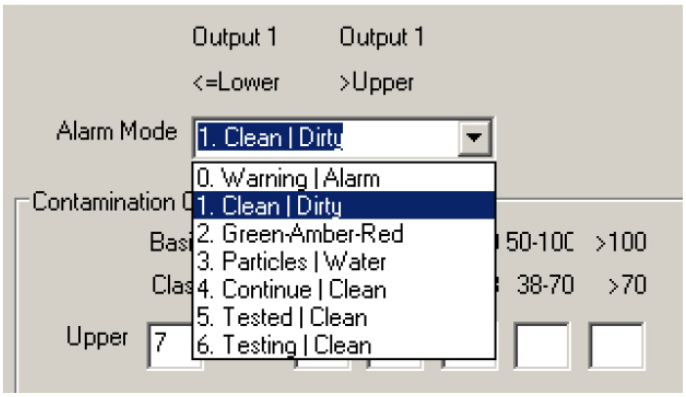


图 5.30

报警模式设置 HPCM 两个开关报警输出的精确功能。

使得 HPCM 可在各场景应用。请注意，对于每种设置，在“报警模式”选择器上方还会显示报警输出的条件。

注：这些报警输出与前面板的 LED 不同，所设定的报警模式不会影响 LED。设置报警模式仅决定两个开关量输出的功能。如果这些输出未被使用，即用户未将其连接到任何设备，则可以忽略该设置和本节内容。

根据客户的要求，偶尔会添加新的模式，这意味着除非使用最新的固件版本，否则可能无法实现全部模式。

报警模式 **0**：警告-报警

	输出1	输出2
在以下情况下开启	>下限	>上线
预期功能	警告	报警

此模式下，HPCM 可以切换外部警告灯或警报。输出 1 是“警告(Warning)”输出，如果超过任何一个下限，则输出。输出 2 是“警报(Alarm)”输出，为类似的上限值报警。

报警模式 **1**：清洁-脏

	输出1	输出2
在以下情况下开启	≤下限	上限
预期功能	清洁	脏

在清洁系统中，通过开启和关闭泵来维持清洁度。

输出 1 是“清洁”输出，当结果小于或等于下限（“干净”）时激活。可用来关闭清洗泵。

输出 2 是“脏”输出，当结果大于上限（“脏”）时激活。可用来启动清洗泵。

报警模式 **2**：绿-黄-红

	输出1	输出2
在以下情况下开启	<上限	>下限
预期功能	绿色	红色

该模式对结果进行编码，使内部报警继电器驱动外部远程三色 LED 指示灯。这是一种特殊类别的 LED，内含红色和绿色发光器，可装在控制面板上。该外部 LED 将根据测试结果变成绿色/琥珀色/红色--与内置 LED 类似。当结果小于上限时，输出1（“绿色”）被打开。当结果大于下限时，输出2（“红色”）被打开。如果结果介于两者之间，则两个输出均被打开，LED 颜色将为琥珀色（即红光和绿光的混合）。

报警模式 3：颗粒-水

	输出1	输出2
在以下情况下开启	清洁度>上限	含水量>上限
在以下情况下关闭	清洁度≤下限	含水量≤下限
预期功能	清洁度报警	含水量报警

当需要对颗粒(清洁度)和含水率分别报警时，可使用该模式。

该模式能够使用上限和下限，使输出具有“滞后性”。如果只需要上或下限，则上、下限均应设置为相同的值。

报警模式 4：继续-清洁

	输出1	输出2
在以下情况下开启	>下限	≤下限
预期功能	继续测试	停止测试/清洁

适用于在“清洁”时，通过一个信号来停止测试（例如，停止泵或向外部控制器发出信号）。

报警模式 5：测试完成-未清洁

	输出1	输出2
在以下情况下开启	测试完成	>下限
预期功能	测试完整信号	“未清洁”信号

适用于通过 PLC 经数字量输出控制测试。PLC 发出一个启动信号，然后监控“测试完成(Test Complete)”输出信号。如果测试失败，PLC 可以探测到 “未清洁 "信号。

该模式下不能选择“连续测试(Continuous testing)”。

报警模式 6：测试中未清洁

	输出1	输出2
在以下情况下开启	测试	>下限
预期功能	测试中信号	“未清洁”信号

上述模式 5 类似。不同的是，输出1 在测试期间处于输出状态，而在测试结束时关闭。

该模式下不能选择“连续测试(Continuous testing)”。

报警模式 **7...** 客户要求的模式

其他报警模式将依据客户要求来定义。

5.4 标准通信协议

5.4 1 397403

HPCM 可以由串行（RS485）接口，Modbus RTU 协议进行控制。HPCM 的设置和每项功能都可由此控制，功能类似威泰科 LPA-View 控制软件。结果和计数都可以用所支持的全部格式提供。我们建议使用 LPA-View 对 HPCM 进行初步配置，并检查其功能是否正常，客户编写的软件只需读取测试结果即可。这样一来，HPCM 测量结果可与一般的机器控制、车辆控制或工厂监控系统集成在一起。

客户如想使用自己开发的 Modbus 控制器软件，请参考本节的其他内容。

最简单的办法是将 HPCM 配置为连续测试模式，测试之间设定一个时间间隔。
例如，测试持续时间为 2 分钟，测试间隔为 10 分钟。
可以选择“自动开始测试(Start Testing Automatically)”，这样设备就不需要启动信号。

然后，可以从相应的 Modbus 寄存器中读取最新的测试结果。

寄存器	功能
56	4µm 结果代码
57	6µm 结果代码
58	14µm 结果代码

5.4.1.1 设置

协议类型	RTU
数据位	8
停止位	1
奇偶性	需要，偶数或无
波特率	自动感应 1200-115200
信号传递	RS485
模式地址	4（或用户设置）

表5.Modbus 协议设置

5.4.1.1.1 通信检查

您应该能从寄存器 0（ Modbus 节点地址 204 ）读取产品 ID 代码。产品 ID 代码是 54237（十进制）或 0xD3DD（十六进制）。

5.4.1.1.2 结果格式

HPCM 可以用几种不同的工业格式（ISO、NAS 等）来显示结果，可以用 LPA-View 轻松设置格式，也可以通过 Modbus 设置。要做到这一点，请将表 5A 中的所需值 0-4 写入测试格式（TEST FORMAT）寄存器 19。出厂设定值为0（ISO 4406:1999）。
所选择的格式不会影响粒子计数值，但会完全改变结果代码和所设定阈值的含义（如果使用）。

注意：如果格式改变，任何设定的报警限值也必须跟着改变，因为这些限值参照的是旧格式。例如，“NAS 11”的限值不能直接用 ISO4406 标准表示。

值	型式	主类示例	个别代码示例
0	ISO 4406:1999		21/20/17
1	NAS 1638	NAS 12	(12 11 11 7 6)
2	AS4059E 表	12A-F	12A/12B/11C/11D/7E/6F
3	AS4059 表1	12 级	12 11 11 7 6
4	ISO 11218 草案	ISO(12)	12 11 11 7 6

表 5A 测试格式寄存器 19

5.4.1.2 结果代码

根据选定的测试格式，最新的测量结果就以数字代码（即数字）的形式呈现。这些代码可以从寄存器 56-63 读取，如表 5B。

寄存器	ISO 4406 代码	AS4059E 表 2 等级	NAS1638/AS4059E 表1/ISO 11218（草案）编码/类别
56	≥4μ	基本	基本
57	≥6μ		
58	≥14μ	A	5-15
59	≥21μ	B	15-25
60	≥25μ	C	25-50
61	≥38μ	D	50-100
62	≥50μ	E	100+
63	≥70μ	F	

表 5B 结果代码 寄存器 56-63

5.4.1.2.1 空值

对于任一格式，特殊值 -32768(0x8000 十六进制)表示 “空”或 “无结果”条件。这样是将“无结果”与 0/0/0ISO 代码区分开。“无结果”可能是因为出现了错误情况，或尚未发出测量命令。此约定也可用于其他参数，例如温度和水含量测量（如适用）。

注意：用户编写程序时应注意，避免在前面板上显示 -32768/-32768/-32768。

5.4.1.2.2 ISO4406

ISO 4406 定义了一组代码值，用来表示粒径超过指定大小 ≥4，≥6和≥14µm(c)的颗粒的计数范围。HPCM 可显示 0 到 24 的代码。这三部分代码就是前 3 个结果代码。
另外我们还提供 21 ~ 70µm(c) 等其他尺寸的等效代码，如表 5B 所示。

5.4.1.2.3 NAS 1638/AS4059E-1/ISO11218

这些代码对应于表中每个尺寸范围内的颗粒数量。“基本”级是这些单个代码中表示数量最高的一个。“基本”级存放在第一个寄存器中，其他等级所在的寄存器如表所示。

对于这些标准，有一个复杂的问题，即它们都定义了一个额外的“00”类。这是一个“比 0 类更洁净”的类别。我们用数值 -1 将其与 0 区分开来。Modbus 寄存器使用“二进制补码”表示负数。如果用户程序将其解读为正数，将显示为 65535(0xFFFF 十六进制)。

类别的范围从 00(-1) 到 12。

5.4.1.2.4 AS4059E-2

AS4059E 表 2 与 NAS1638 也有一些相似之处。在 Modbus 寄存器的表示方式上，主要的区别是多了一个 4-6µm(c) 的尺寸范围，并增加了一个额外的“000”类。这里用数字 -2 表示。如果用户程序将其解读为正数，则会显示为 65534 (0xFFFE hex)。

5.4.1.2.5 温度和含水量测量

这些数据存储在温度寄存器 33 和 RH 寄存器 34 中。这些值的缩放比例为 100，即分别用 1234 和 5678 表示 12.34°C 和 56.78% 的RH。温度可能会变为负值，在这种情况下，通常使用“二进制补码”表示。大多数控制器应能够正确读取以这种方式编码的“有符号整数”（如果将其解释为负数，则会显示为大正数，例如 65535）。

如同污染结果代码的含义一样，特殊值 -32768 (0x8000 十六进制)再次用于表示 "无结果"。原因可能是传感器故障或设备仍在启动。

5.4.1.3 进行测试

5.4.1.3.1 命令测试开始

如果 HPCM 监测的是单台机器，通常会配置成连续自动测试，这样就可以如上所述随时读取污染测量结果。然而，有些应用场合需要一个明确的测试开始和测试结束节点，例如生产线末端的生产测试，每个结果都与一个单独的被测对象关联起来。

在这种应用场景下，可将按钮(或继电器)或前面板按钮连接到 HPCM 启动信号，也可以通过 Modbus 发送程序命令。

要开始或重新开始测试，将数值 1 写入命令寄存器 21。测试持续时间可以在安装前使用 LPA-View 设置，或者将所需的测试时间（以秒为单位）写入测试时间寄存器 18。

5.4.1.3.2 测试状态

寄存器 30 包含一个测试状态代码，通过一个数字表示 HPCM 当前状态。如果需要，系统可以通过这个代码远程监测 HPCM 的运行情况，从而进行更具体的诊断。
注：故障情况也会在前面板 LED 上显示，而故障情况下的“无结果 ”则使用前面所述的特殊值表示。

5.4.1.3.3 测试完成

寄存器 36 指示测试完成。这包含一个0 到 1000 之间的数字，表示测试进度（LPA-View 也利用该值驱动测试进度条）。

5.4.1.4 粒子计数

有些量是（或可能变得）太大了，无法存储于一个 16 位的寄存器。例如 4µm 的粒子数很容易超过 65535。那么就使用两个连续的寄存器来表示，构成一个 32 位整数。举例，存储在寄存器40和41中的一个 32 位无符号整数的值可用公式计算。

值=(65536×(寄存器40))+(寄存器41)

粒子计数存储在寄存器 40-55 中，如表 5D 所示。有8对寄存器；借助两个连续的 Modbus 寄存器，每对寄存器将一个计数通道编码为32位整数。每 100 毫升的计数值。

颗粒尺寸根据 ISO4406:1999 表示如下，即等效投影面积直径。选定尺寸后，便可以获得所有支持的编码标准（NAS，ISO ...）。所有的计数都是累积的。

可以通过减法计算差数。例如，NAS 5-15μm 的计数利用 14μm(c) 的计数减去 ISO 6μm(c) 的计数。

编号	功能	备注
40-41	≥4μm (c)	
42-43	≥6μm (c)	≥5μm (NAS)
44-45	≥14μm (c)	≥15μm (NAS)
46-47	≥21μm (c)	≥25μm (NAS)
48-49	≥25μm (c)	
50-51	≥38μm (c)	≥50μm (NAS)
52-53	≥50μm (c)	
54-55	≥70μm (c)	≥100μm (NAS)

表 5D 粒子计数寄存器

5.4.1.5 报警

5.4.1.5.1 报警模式

HPCM 包括两个继电器输出，可以发送装置状态信号。通常用于不使用 Modbus 接口的“独立”应用场合（因为 Modbus 控制器/PLC 可提供所有的数据结果，可以直接使用）。
有多种预设的“模式”决定继电器的具体功能。详见报警模式部分（5.3.3.9.2 节）。

这些模式通常在安装时借助 LPA-View 进行设置。但也可以使用 Modbus 来设置这些继电器的工作模式，将相应的整数写入报警模式寄存器 26。

5.4.1.5.2 报警阈值

可设定颗粒物污染上、下限。
这是两组，每组 8 个寄存器，分别代表微粒污染的“上限”和“下限”。两组寄存器分别是 64-71 和 72-79。
这些都用结果代码表示，格式参考 5.4.1.2节。特殊值 0x8000（十六进制）表示某一限值为“不关心”类。

5.4.2 CAN-bus

HPCM 支持主流的 CAN-bus 基本报文格式标准 CAN2.0A（11 位标识符）和 CAN2.0B（29 位标识符）。J1939 和 CanOpen 是建立在这些基本标准上的更高层次的协议。CanOpen 使用 CAN2.0A 而 J1939 使用 CAN2.0B 标准。HPCM 不支持这两种协议。相反，它定义了一些 CAN-bus 消息来进行数据通信。然而，HPCM 支持消息标识符，支持与 J1939 和 CanOpen 协议相关的操作。一般情况下，HPCM 可以上述任一种协议的 CAN-bus 系统和其他 CAN-bus 系统一起使用。

产品安装

1.安装

- 按照前面第5节中的详细说明检查 HPCM， 并进行常规安装。
- 运行 LPA-View 的计算机对 HPCM 进行一次性的常规配置检查，例如，将其设置为连续测试，并在开机时自动开始测试。这个过程已在前面的第 5 节中描述。您需要一个合适的 RS485 接口，如 HPCM-USBi。
- 使用软件配置 CAN-bus 网络所需的特定参数，例如配置 CAN-bus 报文 ID 和波特率。

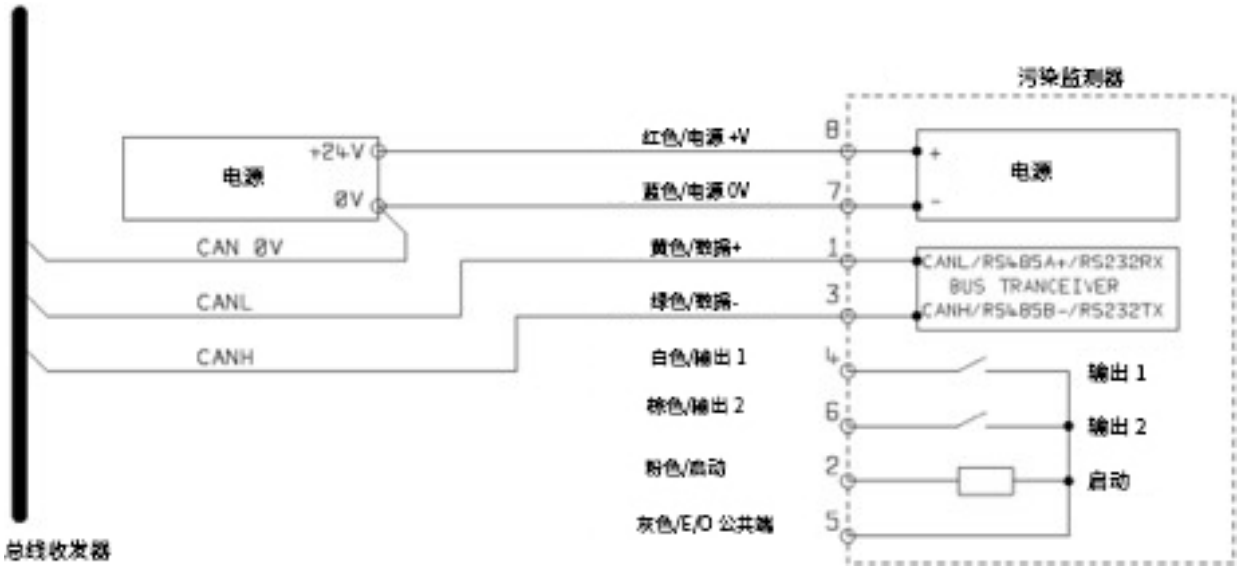


图 5.31

- 将 HPCM 连接到您的 CAN 总线网络，并提供 24VDC 电源，如图 5.31 所示。
- 在每个设定的测试时间间隔后，HPCM 会自动发出测试结果信息。
- 配置您的CAN总线控制器m以侦听上面配置的消息。
- HPCM 需要一个直流电源和两个 CAN-bus 信号 CANL 和 CANH，如图 1 所示。途中的数字是插入 HPCM 圆形连接器的引脚号。
- CAN-bus 要求网络的两端都要端接。这必须在 HPCM 的外部完成。
- CAN-bus信号 CANL 和 CANH 参考系统的 0V 节点。相对于 HPCM 0V 节点，这些信号应该保持在 ISO-11898-4 CAN-bus 标准允许的共模范围内。共模范围是 -2V 到 +7V。可以将 HPCM 0V 和 CAN-bus 控制器的 0V 连接在一起。图中的 “CAN 0V” 线展示了这种连接方式。(如果 CAN-bus 控制器和 HPCM 都连接到车辆底盘上或其他形式的“接地”，两者则不需要接在一起)。
- 这里还有其他线路用于开关报警和启动信号（可选）。这些内容在 5.1.2 节中单独描述。

2. 配置

5.4.2.2.1 使用计算机软件进行配置。

免费的 LPA-View 软件包用于对 HPCM 进行初始配置。一旦配置完成，装置就可与 CAN-bus 网络建立通讯。

HPCM 的设计保持了最大的灵活度。有多种方式设置工作模式、测试结果格式、报警设置、下载存储数据等。

最简单的方法是使用 LPA-View 配置测试参数和结果格式。然后客户的应用程序只需读取结果即可。

CAN-bus 参数可通过通信设置对话框进行配置，可从 HPCM 设置对话框进入（见5.3.3节）。

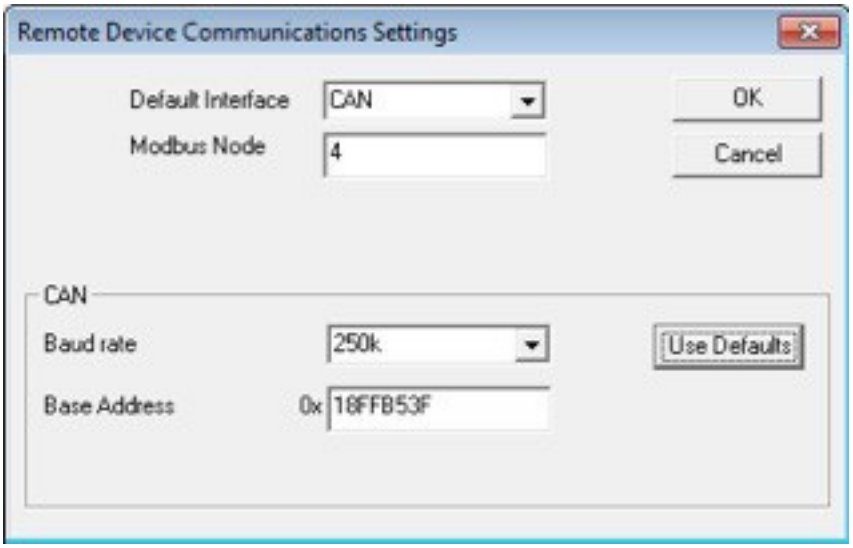


图 5.32 通信设置对话框

HPCM 可以使用具有 11 位标识符的 CAN2.0A “基本”格式或具有 29 位标识符的 CAN2.0B “扩展帧”格式。

5.4.2.2.2 CAN2.0B 和 J1939。

默认的 29 位格式是为与 J1939 标准兼容而设计的。HPCM 还可与允许接收原始 CAN-bus 2.0B 标识符的系统一起使用。

对话中显示了默认的 CAN-bus 设置。HPCM 使用从所选的消息标识符起始的一系列消息标识符传输数据。如果按下“使用默认值”按钮，程序将生成适用 J1939 协议的标识符（即会使用从 0x00FFB53F 开始，分配给专有应用程序的 PGN）。

在每次测试结束时，HPCM 将使用选定的 CAN-bus 标识符生成 “测试结果代码”。
在一个 J1939 网络中，测试结果将显示为 PGN 0x00ff00。不使用 J1939 的用户可以简单地侦听对话框中的标识符消息，例如 0x18FFB53F。

5.4.2.2.3 CAN2.0A 和 CanOpen

11位的格式是为与 CanOpen 标准兼容而设计的。它也可与任何允许接收原始 CAN-bus 2.0A 标识符的系统一起使用。
为了使用 11 位标识符(CAN 2.0A)，请为 “基本地址(Base Address)”设置一个低于 0x7ff 的值。
例如对于CanOpen网络，可使用 0x182。这将就能把消息 ID 与 CanOpen“预定义连接集(pre-defined connection set)”对应起来。

1.操作

5.4.2.3.1 CAN总线设置

CAN 总线物理层	ISO-11898-2
协议类型	CAN2.0B（29位标识符） CAN2.0A（11位标识符）
波特率	用户设置 1M/800k/500k/250k/125k/100k/50k/20k/10k
标识符范围	用户设置

5.4.2.3.2 操作

通常，安装程序将 HPCM 配置为自动开始连续测试。在每个设置的测试间隔结束时（例如 2 分钟），HPCM 将使用设置的 CAN 标识符（例如，使用十六进制表示法的0x18FFB53F）发出 CAN“结果代码”消息。因此，典型的 CAN 消息可能是：

	字节							
标识符	1	2	3	4	5	6	7	8
0x18F-FB53F	12	8	2					

5.4.3 模拟 4-20mA 模式

HPCM 提供两个模拟 4-20mA 电流环路输出 A 和 B。要能够传输两个以上参数，可以选择几种不同的模式以适合该应用。

5.4.3.1 固定 - NAS1638 和相对湿度

HPCM 结果格式必须设置为 NAS1638。然后，输出仅指示 NAS1638 污染等级和相对湿度水平，如下所示：

输出 A	污染代码 =mA-5	4mA NAS 00 5mA NAS 0 6mA NAS 1 … 17mA NAS 12 20mA 超量程
输出 B	相对湿度百分比 =(mA-4)*100/16	4mA 0% 相对湿度 5mA 6.25% 相对湿度 20mA 100% 相对湿度

5.4.3.2 时间复用方案

这些方案按时序在单个输出(A)中输出结果参数。该模式将用于将结果参数读取到 PLC 中。需要对 PLC 进行编程，以在正确的时间读取每个参数。
这些模式仍在开发中。请联系威泰科了解详细信息。

- 我们输出小于 5mA(4.0mA)的电流1秒以指示“帧”的开始，在以下示例中用<SYNC>表示。PLC 需要连续检查这种情况，以便 PLC 可以启动计时器序列来获取结果。
- 参数按顺序输出，每秒输出一个参数，直到列表末尾。
- 我们使用大于 20mA(24mA)的“超出范围”电流来表示参数不可用。
- 然后重复该序列

相对湿度编码

相对湿度值根据以下公式进行编码：
mA = 6 + (RH% / 10)
或者
RH% = (mA–6) * 10

因此相对湿度 0% =6mA，相对湿度 100% =16mA（最大合法测量值），不可用=24mA

温度编码

以摄氏度为单位的温度根据以下公式编码：
mA = 10 + (°C / 10)
或者
°C = (mA – 10) * 10

NAS1638、AS4059E1 和 ISO11218
参数按以下顺序输出：

<SYNC> <CLASS> <CLASS 5-15um> <CLASS 15-25um> <CLASS 25-50> <CLASS 50-100> <CLASS 100+> <RH> <TEMP> <...>

这些污染等级编码为：

等级 = mA -7

例如：00 级 = 6mA，0级 = 7mA，1 级 = 8mA...12 级 = 19mA，偏离刻度 = 20mA

ISO4406
参数按以下顺序输出：

<SYNC> <ISO4> <ISO6> <ISO14> <ISO21> <ISO25> <ISO38> <ISO50> <ISO70> <RH> <TEMP> <...>

ISO4406 代码编码为：

mA = 6 + ISO/2
或者
ISO = 2 × (mA – 6)

因此6mA = ISO 0，20mA = ISO28

AS4059E2
参数按以下顺序输出：

<SYNC> <BASIC> <A> <B> <C> <D> <E> <F> <RH> <TEMP> <...>

AS4059E2 污染代码编码为：

mA = 6 + (代码 + 2) / 2)
或者
代码 = 2 × (mA – 6) – 2 = 2 × mA – 14

因此6mA = -2 = 000、6.5mA = -1 = 00、7.0mA = 0、7.5mA = 1、13mA = 12 = 最大有效读数、20 mA = 超量程

5.4.3.3 时间复用方案2

此方案将参数输出为电流，并且使用的值设计为直接在可编程过程仪表上查看。没有“sync”值，但最终参数将保留生效 2 秒钟，而不是 1 秒钟。为避免混淆，相对湿度通道不输出温度（仅为静态相对湿度值）。另一个通道仅输出总污染代码值，但 ISO4406 除外（在 3 个 ISO 代码之间循环显示）。

5.5 处置

- 所有 HPCM 产品都放在装有泡沫的纸板箱中运送，应正确地回收这些纸板箱和泡沫。
- 与 HPCM 一起使用的液体应完全排干并根据EU废物框架指令和 ISO44001 进行处置

相关产品

6.1 HPCMUSBI

HPCM-USBi 是一种即插即用的解决方案，可轻松将计算机连接到HPCM。

它包括一个 USB:RS485 接口，而且模块已预先连接了 HPCM 电缆。提供了一个额外的模块，用于客户与外部设备的任何接线。

可以使用提供的外部直流适配器为整个系统供电，或者如果在使用过程中始终连接计算机，则可以直接通过 USB 电缆供电。
注意：计算机应始终接通电源。

单独的产品用户指南中提供了详细的安装和使用说明。

7 故障排除/常见问题解答

7.1 产品滥用

- 产品应连接至产品额定范围内的电源，而不应直接连接至电源。
- 该产品应连接到液压管路上；不得超过产品的压力上限
- 在安装和使用 HPCM 时，切勿将连接软管放在地板上。
- 操作员应遵守先前在操作地点设定的所有标准操作程序以及制造商要求的程序。
- HPCM 不适合在爆炸性环境或 ATEX 区域中使用。
- 将测试点/软管拧得太紧会损坏螺纹，导致设备故障。
- 本产品设计为不含移动组件。如果在超出其流体粘度规格范围内使用本装置，则本装置将标记流量错误并将该测试结果作废。

7.2 故障查找

7.2.1 LED 闪烁/故障代码

HPCM 前面板 LED 指示灯通过几种白色闪烁方式（红色背景）来指示故障。闪烁的次数表示故障代码，带屏幕的版本也会显示故障代码和功能：

1. 光学 - 光学故障可能表示 LED 指示灯故障或光路阻塞。尝试用石油醚冲洗，或寄回给威泰科。

2. 流量低 - HPCM 通过测量颗粒物的过渡时间来估算流量。“流量低”警告表示流速低于建议的最低级别(A)。请注意，在清洁系统（例如冲洗/清洁设备）上使用时，应在设置中禁用该报警，在这种系统中，颗粒物数可能达到 14/12/10或 更低。

3. “流量高”警告表示流速高于建议的最高级别。这将降低颗粒物计数的准确性。

4. 记录 - 数据记录存储器出现故障。

5. 水传感器 - 水传感器故障。

(A) 装置仍可以工作，但可能更容易受到压力波动引起的错误的影响。如果没有检测到任何颗粒物（即流体完全
“干净”），也会发出此警告。在这种情况下，仍会生成正确的结果，例如 0/0/0。

7.2.2 测试状态

状态显示在 HPCM 屏幕上。根据下表，屏幕包含一个数字，指示 HPCM 的当前状态。如果需要，这允许系统远程监控 HPCM 操作，从而允许进行更具体的诊断(B)。

值	功能	备注
0	未就绪	装置正在通电或出现问题
1	就绪	装置正在通电或出现问题
2	测试	正在进行测试
3	等待中	测试之间等待(D)
128	光学故障	LED 故障/传感器阻塞/填充了空气
129	流量低故障	流量太低，无法进行可靠的测试(E)
130	流量高故障	流量太高，无法进行可靠的测试
131	记录故障	数据记录故障
132	水传感器故障	水传感器故障

表7A

(B)但是，故障状况也显示在前面板 LED 上，如果使用特殊结果值来指示故障（如上所述），则显示“无结果”。
(C)用户尚未将测试设置为自动进行。
(D)用户设置了非零测试间隔。
(E)或流体完全干净（颗粒计数为零）。如果有问题（例如清洁设备），用户可以关闭流量报警。

7.2.3 其他故障

从样本中获得意外结果

- 检查系统和 HPCM 两端的微孔压力软管是否已完全连接。注意：由于软管端现在处在大气压力下，因此从 HPCM 中卸下任何一根软管均不表示流过 HPCM。应验证 HPCM 两端的压降。
- 确认通过 HPCM 的流量在装置的范围内。
- 水位/充气程度过高

“远程设备”对话框不响应按下的按钮

- 检查在“远程设备”对话框中是否选择了正确的 COM 端口。
- 检查是否已安装 USB 驱动程序。
- 断开 HPCM 的电源，然后重新连接电源。

如果 HPCM 受到过度污染，并且疑似存在堵塞，则用适当的溶剂冲洗可能会清除堵塞。

标准的 HPCM 装有 FKM 密封件，因此可以使用石油醚或异丙基异丙醇清除堵塞。

请勿使用丙酮

7.3 测试持续时间

设置的“测试持续时间(Test Duration)”是在更新测试结果之前计算累积颗粒物的时间长度。默认值 120 秒可能适合大多数应用。但也可以设置其他值。

较短的时间可使设备对清洁度变化做出更快的响应。为了减少生产线情况下的产品测试时间，可能有必要这样做。

较长的测试时间可使装置计算清洁度变化的平均值并产生更稳定的结果。对于较大的颗粒物尤其如此。在清洁系统中，这种颗粒物很少，因此需要对大量流体进行采样，以在统计上有意义的数量进行计算。

另一个因素是流速。这可以与循环时间进行权衡，因为更高的流量可以在更短的时间内对相同量的流体进行采样。

“非常干净”的系统 – 需要更长的测试时间/更高的流量。

“普通”或“脏”系统 – 较短的测试时间或较低的流量也可以接受。

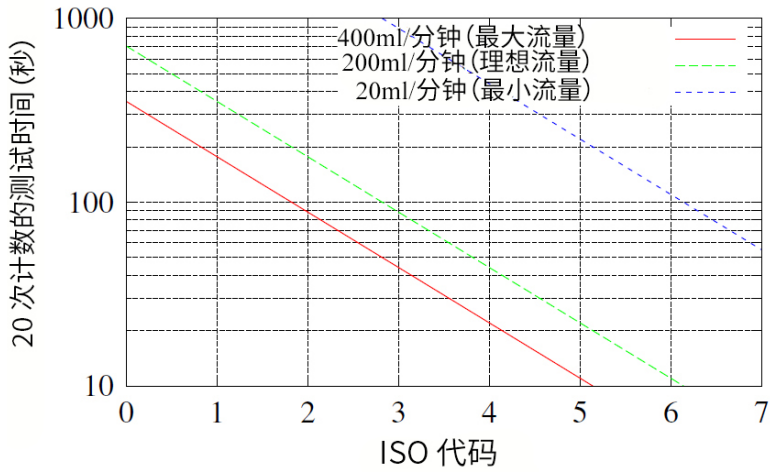


图7.1 通过 ISO 代码进行可靠指示所需的测试时间

故障排除/常见问题解答

8 参考

8.1 有关 Modbus 的更多信息

HPCM 是 Modbus 从属。也就是说，它仅响应 Modbus 控制器（Modbus 主站）发送给它的命令。控制器可以是在 PC 或 PLC 上运行的程序。

Modbus 请求将发送到已配置的 HPCM 节点地址。如果网段上只有一个 HPCM，则可以使用“永久地址”204。如果有多个 HPCM，则必须为每个 HPCM 配置唯一的节点地址。
注意：这不是 Modbus 规范的一部分（而且实际上违反了该规范）。除了其他设置值之外，HPCM还将始终在节点地址 204 上进行响应。这样做是为了让 LPA-View 可以直接连接，而无需配置或扫描网络。

主站定期向 HPCM 节点地址发送 Modbus 命令“frame”。HPCM 通过响应帧确认每个请求。

8.1.1 Modbus 寄存器

Modbus 协议定义了多种类型的信息交换命令（“功能代码”）。但是，为了简化实施，HPCM 仅使用一种类型：Modbus“寄存器”。从概念上说，HPCM 作为 Modbus 寄存器的集合出现。每个寄存器都有编号，HPCM 有 125 个寄存器。
每个寄存器都有一个数字，代表一定数量。例如，寄存器编号 2 包含一个表示 HPCM 软件版本的编号。

8.1.1.1 寄存器编号

此处显示的地址是“线路”上显示的地址。不幸的是，某些 Modbus 控制器可能会将这些地址转换为不同的地址。例如，对于某些控制器，用户将需要使用从 40000 开始的地址，而不是 0 开始的地址。
HPCM 使用 0-124 之间的寄存器（这允许所有寄存器装入单个 Modbus 帧中）。寄存器可以分为以下几类：

状态寄存器 – 这些是“只读”寄存器，用于指示测试结果和 HPCM 状态。可以随时自由读取这些寄存器（但测试结果仅在成功测试后才有效）。

设置寄存器 – 这些是用于保存 HPCM 设置的读写寄存器。注意不要误写入到其中任何一个寄存器，否则 HPCM 设置将被更改！

校准寄存器 – 未在此处记录的一些寄存器是受保护的设置，只能在出厂校准期间变更。

参考

编号	功能	单位	表示方法
0	产品 ID		无符号整数
1	协议 ID		无符号整数
2	固件版本	x100	无符号整数
3	硬件版本		位图
4-5	机器序列号		32 位无符号整数
6	Modbus 地址		整数
7	忽略初始N		无符号整数
8-9	测试编号		32 位整数
10-17	测试参考		16 个压缩字符数组
18	测试持续时间		无符号整数
19	测试格式		
20	测试模式		
21	命令		无符号整数
22-23	测试间隔	S	无符号 32 位整数
24-25	日期/时间	日期	无符号 32 位整数
26	报警模式		无符号整数
27	预留		
28	故障		
29	预留		
30	状态		无符号整数
31	状态标志		
32	LED级别		无符号整数
33	温度	°C x100	
34	相对湿度	% x100	
35	峰值脉冲		无符号整数
36	测试完成		无符号整数

编号	功能	单位	表示方法
37	流量指示		
38-39	预留		
40-55	颗粒物计数		
56-63	结果代码		
64-71	污染上限		
72-79	污染下限		
80	水位上限	% x100	有符号整数
81	水位下限	% x100	有符号整数
82	温度上限	°C x100	有符号整数
83	温度下限	°C x100	有符号整数
84-85	记录间隔	秒	无符号 32 位整数
86-87	最后下载	日期	无符号 32 位整数
88	语言		无符号整数
89-116	预留		
117-118	校准到期	日期	无符号 32 位整数
119-120	最后校准	日期	无符号 32 位整数
121	预留		
122	最后校准 LED 级别		
123	初次校准 LED 级别		
124	预留		

表 8A Modbus 寄存器映射

8.1.1.2 表示方法

Modbus 寄存器 - 所有数量均使用 Modbus 寄存器表示。Modbus 寄存器为 16 位（十进制为0至65535，十六进制为0至0xFFFF）。

无符号整数 - 这些就是单个 Modbus 寄存器。每个寄存器可以取 0 到 65535 之间的值。
它们可能是简单的数字量，例如“以秒为单位的测试时间”。也可以是诸如“结果格式”之类的枚举，其中“0”表示 ISO4406，“1”表示 NAS1638 等。

有符号整数 - 这些数字用于可能变为负数的数量，例如°C。有负号整数也用于采用了某些格式（类似于 NAS1638）的结果代码，此时我们必须将 NAS 的“00”类表示为-1，将“000”类表示为 -2。
像在计算中一样，有符号整数使用“二进制补码”标准在单个 Modbus 寄存器中表示。如果用户编写的程序错误地将有符号整数解释为无符号整数，则仍将正确解释正数。但是，较小的负数将显示为大的正数。特别是 -1 显示为 65535，-2 显示为 65534。解释上述 NAS 代码时可能遇到这些情况。

编写处理 NAS 代码或温度测量的软件时需要谨慎。

32 位无符号整数 - 一些数量太大（或可能变得太大）而无法放入单个 16 位寄存器中。例如，测试编号最终可能会增加到 65535 以上。这些项目使用两个连续的寄存器表示。通过这种组合构成一个 32 位整数。例如，可以使用以下公式计算存储在寄存器 8 到 9 中的 32 位无符号整数的值：

值 = (65536 × (寄存器8)) + (寄存器 9)

位图 - 位图仍然是单个 16 位 Modbus 寄存器，但是它们具有特殊的解释。寄存器中的每个“位”都有单独的功能。最重要的一个例子是“状态标志”寄存器（31）。每个寄存器位对一个单独功能进行编码，例如“结果有效”、“新结果”、“温度过高报警”等。在本文档中，位从 0 开始，0 是最低有效位。
用户编程环境（例如 PLC 编程系统或高级计算机语言）通常具有一些功能而允许轻松访问寄存器中各个位值。

数组 - 数组就是在连续寄存器中压缩的一系列对象。例如，“结果代码”位于 8 个寄存器的数组中。代码[0]在寄存器 56 中，代码[1]在寄存器 57 中，依此类推。
对于 32 位整数数组，每个元素本身占用 2 个寄存器，因此使用的寄存器数量是数组中元素的两倍。对于颗粒物计数数组，有 8 个颗粒物计数，因此将它们存储在 8×2 = 16 个寄存器中。

压缩字符 - 用于对用户可设置的“测试参考”字符串进行编码，用于标记每个测试。每个 Modbus 寄存器中的字符打包为两个。用户编写的 Modbus 程序中可能不会使用此功能，但原则上可以将每个测试的测试参考设置为不同的值。测试参考字符串由 16 个字符组成，压缩为 8 个连续寄存器的数组。

日期/时间 - 日期以 32 位无符号整数表示日历日期和时间（这是自 1970 年 1 月 1 日以来的秒数）。用户程序通常不必对此进行处理，但是原则上可以从寄存器 24-25 读取或设置实时时钟。在开发过程中，能够读取时钟并看到秒的连续递增值可能很有用。

8.1.1.3 寄存器功能

8.1.1.3.1 测试模式

出厂设置值：0
这是“测试模式”，每个位代表一个选项，对应于 HPCM 设置屏幕上的复选框（请参阅我们的 LPA-View 软件和 HPCM 手册）。

寄存器的每一位对一个复选框进行编码。
所有位的出厂设置模式均为 0，因此所有复选框均已关闭。如果您的系统非常干净，则可能需要打开位 8（清理时禁用流量低报警）。

位	功能	备注
0	CYCLE_COTINUOUS	连续记录
1	START_TEST_AUTOMATICALLY	自动启动测试
2	CONTINUOUS_STOP_WHEN_CLEAN	清洁时停止测试
3	CONTINUOUS_LOG_EVERY_TEST	连续模式：记录每个测试
4	CONTINUOUS_CONFIRM_TARGET	重复最终测试以确认达到目标水平
5	RESERVED	
6	RESERVED	
7	SIMULATE	产生模拟测试结果
8	LOW_FLOW_CLEAN_DISABLED	防止在干净的系统上出现虚假的低流量报警

表 8B 测试模式寄存器的位定义

8.1.1.3.2 命令寄存器

这是寄存器21。特殊之处在于，将某个数字写入该寄存器并不会存储该数字，而是命令 HPCM 根据写入的数字执行某个功能。主要命令是“开始(START)”，但是为了完整和避免在此记录其他命令。

位	功能	备注
1	START TEST	开始或重新开始测试
2	RECALCULATE	
3	强制输出1开启	
4	强制输出 1 关闭	
5	强制输出 2 开启	
6	强制输出 2 关闭	
7	TEST MODE ON	LED 指示灯闪烁并进行输出
8	TEST MODE OFF	
9	STOP	中止正在进行的测试
10	LOG ERASE	注意！
11	LOG SEEK END	
12	LOG SEEK PREVIOUS	

表 8C 命令寄存器

8.1.1.3.3 状态寄存器

这是只读寄存器 30。它包含指示 HPCM 状态的数字（枚举）。

8.1.1.4 位图功能

8.1.1.4.1 状态标志位图

这是只读寄存器 31。它以位图格式表示各个项目的状态。

- 位 0 至 2 让外部设备（例如 LPA-View 或 PLC/MMI）可以智能地显示、更新和记录结果。
- 位 3 和 4 可用于监视测试进度。
- 位 5 至 10 用于生成报警。根据所选的报警模式，这几个位将操作报警继电器输出。但是它们也可以由 PLC/MMI 程序直接监测，并用于驱动指示器。
- 内部使用位 11 来检测 HPCM 是否由 Modbus（从PLC 或 LPA-View）控制。
- 最后，位 12 至 14 反映了 HPCM 的“启动信号”输入和报警输出继电器的状态。

位	功能	备注
0	RESULT_VALID	当前结果有效
1	RESULT_NEW	有新结果
2	RESULT_LOG	应记录当前结果
3	TESTING	正在进行测试
4	COMPLETE	测试完成
5	ALM_HI_COUNT	颗粒物计数高报警
6	ALM_HI_H20	含水量高报警
7	ALM_HI_TEMP	温度高报警
8	ALM_LO_COUNT	颗粒物计数低报警
9	ALM_LO_H20	含水量低报警
10	ALM_LO_TEMP	温度低报警
11	REMOTE_CONTROL	装置处于遥控状态
12	IO_IP	启动信号输入
13	IO_OP1	报警输出1
14	IO_OP2	报警输出2
15	UNUSED	目前未使用

表8D 状态标志

8.1.1.4.2 故障标志位图

这是只读寄存器 28（需要固件 0.43 或更高版本）。它以位图格式表示检测到的设备或安装故障。故障也可以在状态寄存器中作为结果代码使用。但是，这些是暂时的，只可能在开始新测试之前短暂出现。

此处的故障位一直保留到下一次测试结束为止（如果故障已消失，则可以将其清除）。

位	功能	备注
0	OPTICAL FAULT	见表8A
1	LOW FAULT	见表8A
2	HIGH FAULT	见表8A
3	DATA LOGGING	见表8A
4	WATER SENSOR	见表 8A

8.1.2 Modbus 的实现

本部分适用于希望自己编程以实现 Modbus 控制器的高级用户。如果用户控制系统已经直接支持成为 Modbus 主站，则不需要阅读本部分。下面描述了一种能够从 HPCM 定期读取数据的最小系统；这种最小系统并非要用作通用 Modbus 实现。

作为本节的背景知识，实施者可以查看 Modbus 源文档：

http://www.modbus.org/docs/Modbus_over_serial_line_V1.pdf
http://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b.pdf

为了从 HPCM 收集数据，用户控制系统需要能够通过 RS485 信号发送 Modbus 命令帧并接收响应帧。
帧由字节序列组成，这些字节序列通过 RS485 接口背对背发送。

可以生成与 Modbus“读取寄存器”命令相对应的命令帧。使用十六进制表示法，返回所有寄存器所需的序列将是 8 个字节的序列：
<0xCC> <0x04> <0x00> <0x00> <0x00> <0x7D> <0x20> <0x36>

HPCM 将该序列解码为：

<0xCC> = <从站地址>
<0x04> = <功能码：读取寄存器>
<0x00> <0x00> = <起始寄存器高位> <起始寄存器低位>（2字节）
<0x00> <0x7D> = <寄存器数量高位> <寄存器数量低位>（2字节）
<0x20> <0x36> = <校验和高位> <校验和低位>（2字节）

然后，HPCM 将返回一个 255 字节长的响应帧，其中包含请求的寄存器内容。

255 字节响应帧如下所示：
<0xCC> <0x04> <0xfa> <250字节数据> <2 字节校验和>

<250 字节的数据>包含请求的 125 个寄存器的内容。每个 16 位寄存器均以高-低（“高位优先”）顺序编码为两个连续字节。
然后，最简单的方法是直接从此响应帧的数据区域中读取所需的寄存器。例如，HPCM 产品 ID 代码显示在 Modbus 寄存器 0 中。因此，它会出现在上方数据区域的前两个字节中，或者从帧开头算起的第 4 和第 5 个字节中。在诸如 C 这样的编程语言中，可以使用如下语句从包含帧的数组中提取产品 ID：

```
unsigned product_id = 256*buf[3+0] + buf[3+1];
```

PLC 或其他编程语言的用户有望使用此处提供的信息进行转换。
HPCM 产品 ID 为 0xD3DD（十六进制）或 54237（十进制）。尝试上述实现时，可以将此事实用作检查。
最后我们来提取测试结果。参考 HPCM Modbus 寄存器映射，测试结果代码显示在寄存器 56 至 63 中。
对于 NAS1638，整个 NAS 代码在寄存器 56 中。因此，程序可以使用等效于 C 语言表达式的逻辑从结果帧中提取整个 NAS 代码：

```
unsigned NAS=256*buf[3+56*2+0] + buf[3+56*2+1]
```

这是 C 编程语言中的一条语句，该语句读取响应帧的第 116 和 117 字节，并通过这两个 8 位字节形成一个 16 位数字。这将读取 modbus 寄存器 56，也就是 NAS 代码。

根据所需的数据，可以使用类似的表达式来读取其他寄存器。

对于 PLC 用户，详细信息将取决于他们自己的编程环境和设施。但希望以上内容可以用作他们自己的实施指南。

8.2 有关 CAN 总线的更多信息

8.2.1 实例演练

实际的应用程序通常会具有一个现有的 CAN 网络，但是在本章中，我们将说明如何使用 USB:CAN 适配器将 HPCM 连接到 PC。

本示例中使用的适配器是 PCAN-USB，可从 Peak System Technik GmbH 或分销商购买。

我们还需要制作一条特殊的电缆以将其连接到 HPCM。

图8.1 PCAN-USB CAN 总线转 USB 适配器

8.2.1.1 所需设备

- 具有 CAN 总线功能的 HPCM
- PCAN-USB USB:CAN 适配器
- HPCM-USBi 接口，用于初始设置 HPCM
- 运行 Windows 且具有 USB 端口的 PC
- 特殊构成的 CAN 总线电缆详细说明如下
- 12 或 24 伏直流电源

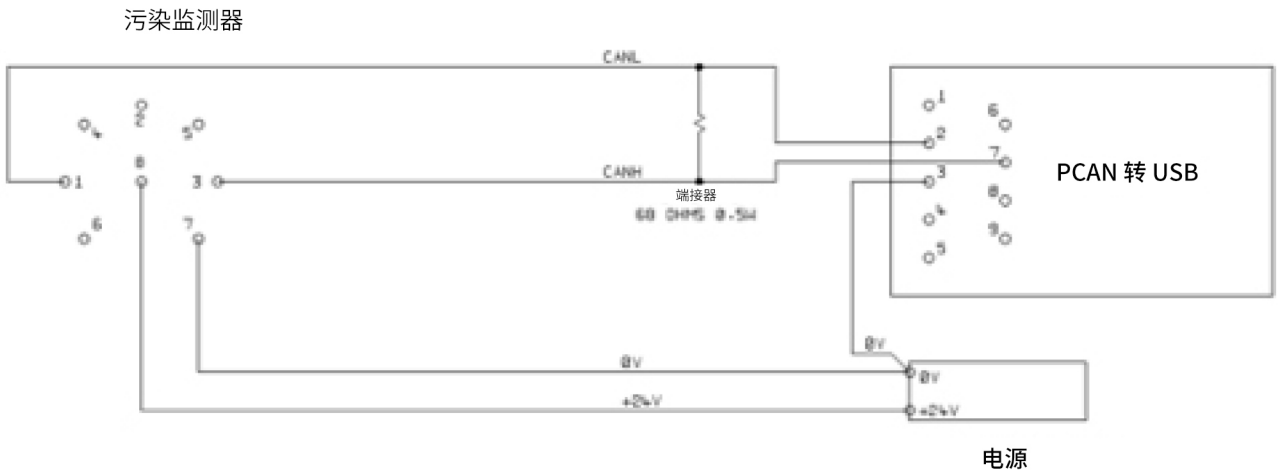


图8.2 将 HPCM 连接器 PCAN-USB 适配器

显示的 “TERMINATOR” 电阻器模拟通常在 CAN 总线网络任一端使用的总线终端电阻器的组合效果。它的值并不重要，50 到 150 欧姆之间的任何电阻值都可以。

8.2.1.2 初始配置

开始时，我们使用 HPCM-USBi 接口进行连接，以便可以使用 LPA-View 轻松配置 HPCM。用户指南的开头部分提供了详细信息，但是一般过程为：

- 安装 LPA-View
- 插入 HPCM-USBi
- 将出现“找到硬件”向导。如果您具有 Internet 连接，则可以让 Windows Update 安装驱动程序，否则在向导中使用提供的驱动程序。
- 将 HPCM 插入 HPCM-USBi
- 启动 LPA-View
- 选择“工具/远程控制”以连接到 HPCM。

8.2.1.2.1 建议的常规设置

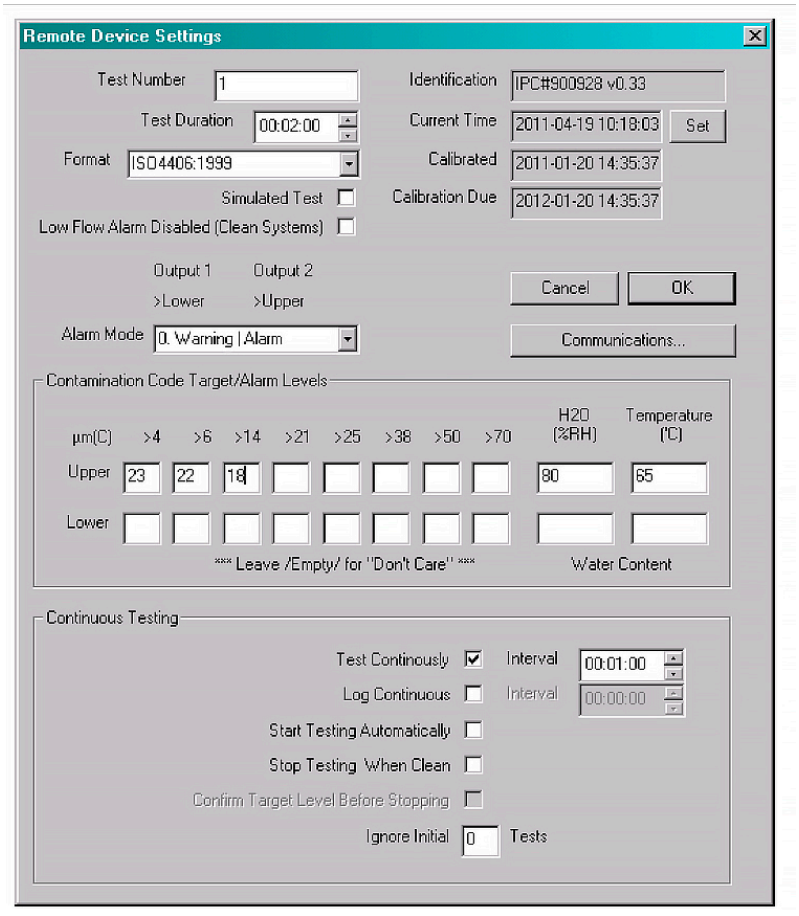


图8.3 常规设置

按“设置(Settings)”按钮以打开“设置”对话框。本次演练的重要设置为：

- 测试持续时间；10 秒
- 连续测试：开启，间隔为 0。
- 自动启动测试：开启
- 清洁时停止测试：关闭
- 模拟测试：开启

注意：模拟测试将导致生成虚拟测试结果，以测试通信和演示设备。在实际应用中进行部署之前，别忘记关闭此功能！

8.2.1.2.2 建议的通信设置

按“通信...(Communications...)”按钮以打开“通信”对话框。见图5.24

如图所示，选择接口、节点号和波特率，然后按“使用默认值(Use Defaults)”分配基本地址。这将定义软件使用的 CAN 消息标识符块的开始（使用与 J1939 标准兼容的值）。

在“通讯设置(Communications Settings)”和“远程设备设置(Remote Device Settings)”对话框中按“确定(OK)”按钮。保持“远程控制”对话框打开的状态。

现在检查是否已将 HPCM 设置为自动执行测试：
- 拔掉 HPCM 圆形接头
- 重新插上接头
- 您应该会在几秒钟内在“远程控制”对话框中看到连接已重新建立。
- 测试应该已经自动开始
- 测试应每 10 秒重复一次
- 您应该看到一个测试结果，这一结果在开始时很高，而在以后的每个测试中都会降低。

关闭“远程控制”对话框并退出程序。拔掉HPCM上的圆形接头。

8.2.1.3 PCAN-USB软件

PCAN-USB 适配器随附软件 CD。这包括一个称为 PCAN-View USB 的简单 CAN 总线诊断实用程序。应从 CD 安装这个软件。
使用特殊的专用电缆和 PCAN-USB 将 HPCM 连接到计算机。打开电源来为 HPCM 供电。
连接 PCAN-USB 并启动 PCAN-View 后，将显示“连接”对话框。

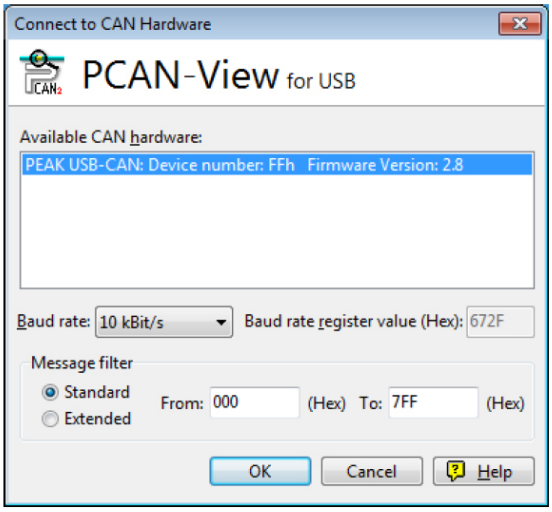


图8.4 PCAN-View 的“连接”对话框

选择与 HPCM 上使用的波特率匹配的波特率，例如 250k。选择“扩展”消息过滤器（以便使用 29 位标识符）。
按“确定”进入 PCAN-View 主屏幕。

8.2.1.3.1 模拟测试

将 HPCM 插入其圆形连接器。它应该开机并开始执行测试。
如果一切正常，则大约 20 秒后，您将看到类似于以下所示的 CAN 消息。
这显示了收到的第二个结果。前 3 个字节 0x17、0x15、0x13 显示 3 个 ISO 代码（显示为十六进制（base16），因此实际代码为 23/21/19）。

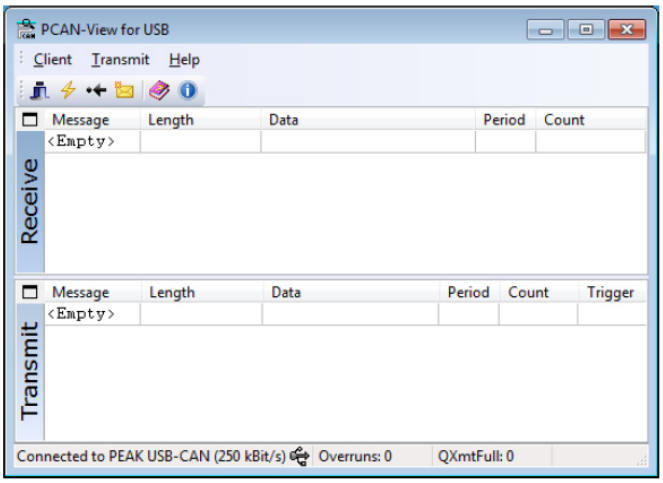


图8.5 PCAN-View 主屏幕

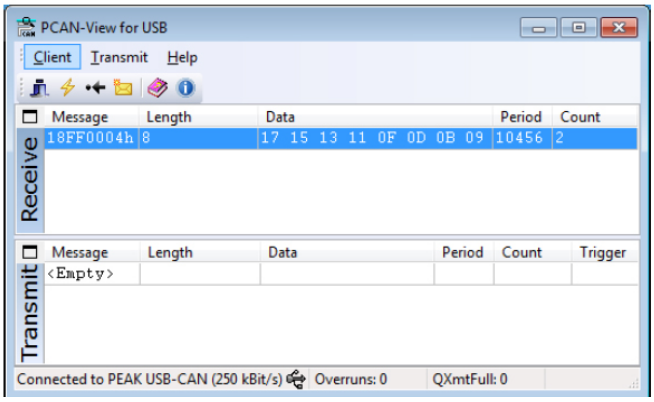


图8.6 接收测试结果代码消息

8.2.2 消息

8.2.2.1 CAN2.0B 和 J1939

HPCM CAN 总线实现设计为与 J1939 网络互操作。实现的方式是将 CAN 总线消息 ID 限制在 J1939 分配的专有范围。避免了 J1939 的高级功能，因此，为使用 J1939 的客户也将能够使用“通用”CAN 总线框架进行通信。对于非 J1939 用户，唯一的要求是他们的网络应支持 CAN2.0（29 位标识符）。

广播消息使用 J1939 PDU2 格式。将定期发送这些广播消息以传达 HPCM 状态和最新测试结果。

对等消息使用 J1939 PDU1 格式。这些消息用于控制 HPCM。这些消息通常是可选的；客户可以选择让 HPCM 自动测试和广播结果。

节点地址（PDU1）	0x3F（J1939“机油传感器”）
命令和配置消息PGN	0xEF3F
广播消息 PGN	0xFFB5 至 0xFFB9
默认广播间隔	1 秒
数据页	0
优先级	6
PDU格式/特定于 PDU	源自 PGN
字节顺序	所有数据均按小端字节顺序

表 8F 用于 J1939 互操作的 CAN 总线参数

8.2.2.2 非 J1939 CAN2.0B 用户

- 综上所述，这意味着通用的 CAN“基本地址”为 0x18FFB53F。
- 然后可以将命令和控制消息发送到 CAN 地址 0x18EF3F00。

8.2.2.3 CAN2.0A 和 CanOpen

在 CanOpen 网络上，结果需要从“预定义的连接集”中作为“过程数据对象（PDO）”进行传输。为此，请确保设置的基本地址等于（0x180 +节点号）。例如，0x182 可将 HPCM 节点地址设置为 2。

8.2.2.4 CAN 总线消息列表

显示的消息 ID 号只是一些示例，并且取决于设置的基本地址。
对于 CAN2.0A/CanOpen，我们有一个示例基本地址 0x182。因此，您会在整个消息 ID 的最后一位看到“2”。CanOpen 将此解释为设备节点号。对于 CAN2.0B/J1939，我们有一个示例基本地址 0x18FFB53F。等效的节点号是“3F”，因此您会看到 3F 出现在所有消息 ID 中。对于其他节点号，请根据需要更改设置的基本地址值。CanOpen 的节点号范围是从 0x01 到 0x7f。J1939 的节点号范围是从 0x01 到 0xff。

参数名称	CAN2.0A ID	CanOpen PDO	CAN2.0B ID	J1939 PGN
结果代码	0x182	传送 PDO 1	0x18FFB53F	0xFFB5
状态	0x282	传送 PDO 2	0x18FFB63F	0xFFB6
水位传感器	0x382	传送 PDO 3	0x18FFB73F	0xFFB7
命令	0x202	接收 PDO 1	0x18EF3F00	PDU1

表 8G CAN 总线消息

8.2.2.4.1 消息：结果代码

每次测试后都会传送此消息。
测试结果以所选测试格式（ISO4406，NAS1638等）中的一组代码来表示。测试结果消息始终为 8 个字节长，压缩后的结果代码如下：

格式：字节	ISO 4406 代码	AS4059E 表 2 等级	NAS1638/ AS4059E 表1/ ISO 11218（草案）编码/ 类别
1	≥4μ	基本	基本
2	≥6μ		
3	≥14μ	A	5-15 μm
4	≥21μ	B	15-25 μm
5	≥25μ	C	25-50 μm
6	≥38μ	D	50-100 μm
7	≥50μ	E	>100 μm
8	≥70μ	F	

注意：“基本”类是个体尺寸类中最高的。
ISO4406 仅定义了前 3 种尺寸（4、6和14μm）的代码。我们扩展了这一概念以涵盖其他尺寸。这样，即使使用 ISO 4406 编码系统，也可以设置大颗粒物的数量限制。

8.2.2.4.1.1 特殊值

结果代码使用一些特殊值来表示不是简单数字的代码。
NAS1638 标准定义了“00”和“000”类，它们比“0”类更干净。我们分别使用值为 -1 和 -2 的带符号整数表示这些值（如果读取为无符号整数，则将显示为 255 和 254）。

8.2.2.4.2 消息：状态

该消息每 1 秒传送一次，因此可以用作“心跳信号”。
但是，如果尚未执行任何测试，则 HPCM 将等待，直到看到其他 CAN 总线活动，然后才会发送任何内容。

字节	位	长度	类型	项目
1-4	1	32	无符号	测试编号
5	1	8	无符号	状态代码
6	1	8	无符号	完成
7-8	1	16	位掩码	状态标志

测试编号 - 当前的测试编号是一个自动递增的整数，也可以将其设置为“测试开始”命令的一部分。这用于区分测试/电路。

状态代码 - 这是一个数字，用于指示 HPCM 的当前状态，或者在检测到问题时显示故障代码。表 III 中列出了这些代码。如果需要，这允许系统远程监控 HPCM 操作，从而允许进行更具体的诊断。

完成 - 0 到 100 之间的数字，表示测试的进度。在设定的测试时间内，该值将从 0 增加到 100。它可用于驱动进度指示器。

状态标志 - 这是一组指示测试状态的标志。

8.2.2.4.2.1 状态标志位掩码

这与表 8D 相同

位 0 至 2 让外部设备（例如 LPA-View 或 PLC/MMI）可以智能地显示、更新和记录
位 3 和 4 可用于监视测试进度。

位 5 至 10 用于生成报警。根据所选的报警模式，这几个位将操作报警继电器输出。但是它们也可以由 PLC/MMI 程序直接监测，并用于驱动指示器。

内部使用位 11 来检测 HPCM 是否由Modbus（从 PLC 或 LPA-View）控制。
最后，位 12 至 14 反映了 HPCM 的“启动信号”输入和报警输出继电器的状态。

8.2.2.4.3 消息：水位传感器

字节	位	长度	类型	项目
1	1	8	无符号	相对湿度百分比
2	1	8	有符号	摄氏温度

8.2.2.4.4 消息：命令

可以通过 CAN 总线将各种命令发送到 HPCM。
对于 J1939 网络，将使用对等（PDU1）消息。
对于 CanOpen 网络，使用接收过程数据对象。

字节	位	长度	类型	项目
1	1	8	无符号	命令字节（0x00）
2	1	8	枚举	(0, 1, 2, …)
3-6	1	32	无符号	参数

枚举	功能	参数
1	启动测试	无
9	停止测试	
13	启动测试	固定测试编号
14	ISO4406 格式	设置ISO4406 结果格式
15	NAS1638 格式	设置 NAS1638 结果格式
16	格式 AS4059_E2	设置 AS4059E 表 2 结果格式
17	格式 AS4059_E1	设置 AS4059E 表 1 结果格式
18	ISO11218 格式	设置 ISO11218 结果格式

8.3 液压系统目标清洁度等级

如果液压系统用户能够在相当长的一段时间内检查清洁度等级，则可以验证这些等级是否可以被接受。

因此，如果没有发生故障，则测得的平均等级很可能是基准。但是，如果条件发生变化，或者如果向系统中添加了对污染物敏感的特定组件，则可能必须修改此等级。如果需要更高可靠性，那么也可能需要提高清洁度等级。

可接受程度取决于三个功能：
- 组件的污染物敏感性
- 系统的运行条件
- 所需的可靠性和预期寿命

污染物代码 ISO4409:1999			对应代码 NAS1638	推荐 过滤程度	典型应用
4µm(c)	6µm(c)	14µm(c)		8x200	
14	12	9	3	3	高精度和 实验室伺服系统
17	15	11	6	3-6	机器人和伺服系统
18	16	13	7	10-12	非常敏感 高可靠性系统
20	18	14	9	12-15	敏感的可靠系统
21	19	16	10	15-25	可靠性有限的一般设备
23	21	18	12	25-40	不连续使用的低压设备

8.4 清洁工作实践

大多数液压系统要求清洁度要控制在 40 微米左右的阈值以下（超出人类视力的极限）。当分析低至 4um、6um 和 14um 的粒子时，您正在谈论的是细胞/细菌大小的物体。这产生了各种挑战，并开始推动行业中更好，更清洁的工作实践。我们的产品位于这一挑战的最前沿，将帮助您管理系统的质量和生产力。

禁止事项

- 请勿在关键系统/过程周围饮食或吸烟。
- 请勿将工具、物品、衣物或其他材料放在关键系统的表面或储罐上。
- 请勿在关键系统上使用开放式储罐。
- 请勿从储液器/储物罐的顶部取样或进行在线分析。
- 请勿设计/使用带有缝隙（内角等）的储罐。
- 不要以为样品看起来很干净就认为真得很干净。您无法看到污染物。
- 请勿在“不受控制”的环境中执行离线分析。例如车间
- 请勿依赖单个测试来代表您的系统。
- 在经过污染程度相对稳定的调试阶段之前，请勿开始使用系统/过程。
- 请勿将流体混入同一系统。这可能会乳化并导致无法进行任何可靠颗粒计数。
- 请勿使用不合适的容器来获取流体样本。

维护/重新校准

9 维护和重新校准

保修	HPCM 的保修期为自收货之日起 12 个月。有关更多详细信息，请参见第 3 节。
重新校准 准。	建议每 12 个月重新校准一次 HPCM。寄回到 威泰科进行重新校

故障诊断和报告

10.1 诊断可疑的 HPCM 读数

为了让我们能够提供响应更快的服务，如果您提供以下信息，将很有帮助：

HPCM 的产品部件号：
产品序列号：

应用	电池组、过滤器推车、系统应用、其他
行业	航空航天、移动设备、工业、船舶、石油和天然气、汽车、其他
安装	永久安装、移动式安装、其他
流体类型	矿物、合成、可生物降解、海底流体、水、柴油、其他。请命名并提供材料数据信息，以确保与内部密封件和内部湿部件兼容
粘度	0-1000 cSt
系统压力	Bar/PSI - 最小/最大可变压力/静态压力
HPCM 的安装方式	压力线返回储液器，压力线返回系统，返回线返回储液器，其他
HPCM 入口和 **HPCM** 出口之间的已知压差	
连接类型	Minimess M16 X 2，微孔软管，¼英寸接头。¼英寸软管，其他
接头软管长度	入口/出口
HPCM 入口压力	Bar/PSI
HPCM 出口压力	Bar/PSI
是否装有单向阀/流量控制阀/针阀	
单向阀的值	Bar/压力
通过 **HPCM** 的指示流量	
应用中的油量	升/加仑
泵流量	升每分钟/加仑每分钟
安装的过滤类型	压力、回流、离线、其他。如果是离线，则过滤器单元的泵流量是多少– 5 lpm、10 lpm、、20 lpm、其他
过滤微米等级	3 微米、6 微米、10 微米、其他
系统运行期间流经过滤器	升每分钟/每分钟加仑数

故障诊断和报告

每天系统运行时间	8 小时、16 小时、24 小时、其他
预期清洁度范围	
实际清洁度范围	
环境温度范围	
系统温度范围	
水分含量（如适用）	0-100%
怀疑错误/故障的原因	为什么您认为 HPCM 无法正确读取
是否进行了实验室分析？	如果是，请提供结果并报告
HPCM 屏幕的图片	屏幕1 - ISO/NAS屏幕；屏幕 2 - 最近 10 个读数；屏幕 3 - 颗粒物计数分布
从 **LPA–view** 下载并发送所有颗粒物计数	
应用程序的图片	
HPCM 屏幕上显示的任何故障	例如，光学故障、流量高、流量低，无读数（-/-/-）
光学故障 **-** 具体的 **LED** 值	具体的 LED 值
备注和意见	

Product Presentation

The HPCM measures and quantifies the numbers of solid contaminants in Hydraulic, Lubrication and Transmission ap-plications. The HPCM2 is designed to be an accurate instrument for permanently installed applications utilising mineral oil as the operating fluid.

The unit can operate using any of the international standard formats ISO 4406:1999, NAS 1638, AS 4059E/F and ISO 11218.

The HPCM incorporates a machine connector for power and PLC connection, capable of RS485, CANBUS or 4-20mA signaling. A separate connector is also provided for simultaneous computer remote monitoring or settings access using RS485 or a USB:RS485 interface.

The integrated data logger records up to 4000 test results internally, for use where a computer cannot be permanently connected.

Simple switched inputs and alarm outputs are provided as alternative means of controlling the dvice and signaling the results. The “full colour” front panel led provides a basic indication of the cleanliness level.

The instrument uses the light extinction principle whereby a specially collimated precision LED light source shines through the fluid and lands on a photodiode. When a particle passes through the beam it reduces the amount of light received by the diode, and from this change in condition, the size of the particle can be deduced.

Benefits

- Live real time monitoring
- Manual, automatic and remote control flexibility
- Moisture and temperature sensing
- Multicolour LCD and LED for clear visual indication of any faults and alarms
- Instant result download on USB versions

Product features

Moisture Sensor

HPCM2 models measure water content using a capacitive RH (relative humidity) sensor. The result is expressed as percentage saturation. 100% RH corresponds to the point at which free water exists in the fluid, i.e. the fluid is no longer able to hold the water in a dissolved solution. This is also normally the point at which damage occurs in a hydraulic system, so is an ideal measurement scale that is independent of the fluid characteristics.

The water saturation point (100% RH) is temperature dependent, so the temperature is measured at the same time. This enables results to be compared meaningfully.

The temperature measured is that of the fluid passing through the unit. Note this may differ from that of the hydraulic system, depending on flow rate, pipe length and ambient temperature. It is not intended to be an accurate indication of system temperature, but to provide a reference for the RH measurement. Nevertheless experience has shown the temperature measured is within a few degrees of that of the hydraulic system, in most applications.

Data Logger

The HPCM includes a built-in data logger, which adds the facility to log and timestamp test results locally within an internal memory, even when not connected to a computer.

- Test logging is determined by the log settings
- Each log entry is time-stamped and contains the HPCM serial number, so that it can be identified later.
- The HPCM memory has space for around 4000 log entries. When full, the oldest log entry is overwritten.

See section 5.3.1 & 5.3.2 for details of how to download the test log via bespoke windows based software.

Data Transfer via USB Stick

The HPCM2 allows direct download via a USB memory stick. With the HPCM powered up, plug the USB stick into the USB connector at the top of the unit.

The screen / indicator will turn yellow briefly as it writes the test records to the USB stick. When complete, it will turn green and the stick can be removed. If there is a problem with the data transfer (stick full or corrupt or not recognised) then the screen / indicator will turn red. If this happens the operator can remove the stick and try again with an alternative.

The USB stick provided with the unit is pre-formatted for the transfer. Other USB sticks may need to be re-formatted (FAT32).

PLEASE NOTE: The USB option is not to be used for anything other than a memory stick for results download. Any subsequent use other than that intended may cause damage to the device

Disclaimer

As part of our policy of continual improvement, Webtec reserves the right to alter the specification without prior notification.

TABLE OF CONTENTS

What this guide is for

This Guide will take you through the installation and instructions for making the most out of your HPCM 2.0.

It contains detailed information to enable you to master the full functionality of the device, as well as key information on safety, waranty, maintenance and accessories.

If you have any queries or issues please go to Section 10 Fault diagnosis and Reporting for more information.

OPERATOR'S GUIDE

1 General Warnings and Information for the End User

1.1 General Safety Warnings

Do not operate, maintain or carry out any procedure before reading this manual. Any individual operating the unit shall wear the following Personal Protective Equipment:

Protective eyewear
- Safety shoes
- Gloves
- Overalls (or other suitable protective clothing)

Before carrying out any machine installation procedures and/or before use, one should scrupulously follow the instructions listed in this manual. Moreover, it is necessary to comply with the current regulations related to occupational accident prevention and safety in the workplace.

Notices aimed at the prevention of health hazards for personnel operating the machine are highlighted in this document with signs having the following meaning:

WARNINGS 	It relates to important information concerning the product, its use or part of this documentation to which special attention must be paid

CAUTION 	It means that failure to comply with the relevant safety regulations may result in mild injury or property damage.

DANGER 	It means that failure to comply with the relevant safety regulations may result in death, serious injury or serious property damage.

Failure to comply with the relevant safety regulations may result in death, serious injury or serious property damage.

GENERAL WARNINGS

OPERATOR	This is any individual whose task is to use the machine for production purposes. The operator is aware of all the measures taken by the machine manufacturer in order to eliminate any source of injury risk in the workplace and takes into account the operational constraints.
PERSONNEL INVOLVED IN SLINGING / HOISTING OPERATIONS	This is any individual whose task is to handle the machine or parts of it. Personnel involved in slinging and hoisting operations are aware of the issues regarding the safe transfer of machinery or parts of it and, therefore, uses appropriate lifting equipment, following the instructions provided by the product manufacturer.
MACHINE SETTER	This is any individual whose task is to set up the machine for its operation. The machine setter is aware of the measures taken to eliminate all sources of injury risks in the workplace and takes into account the operational constraints. The machine setter takes all the appropriate precautions in order to operate in utmost safety conditions.
MAINTENANCE TECHNICIAN	This is any individual whose task is to carry out maintenance activities on the machine. The maintenance technician is aware of the possible danger situations that may arise and takes the appropriate precautions in order to eliminate the risks of accidents in the workplace.
ELECTRICIAN	This is any individual whose task is to carry out maintenance activities on the electrical wiring of the machine. The electrician is aware of the possible danger situations that may arise and takes the appropriate precautions in order to eliminate the risks of accidents in the workplace.

1.3 Operator Position and Dangerous Areas

No operator is required for operating the unit. However, the following areas are to be considered dangerous: The ones close to the electric motor because of live equipment with potentially hot surfaces.

WARNINGS 	The unit shall be taken out of service and/or dismantled in accordance with the current regulations in force in the country where the machinery is installed

CAUTION 	The machinery is not suitable for outdoor use and all the electrical devices have a protection class starting from IP 55 upwards.

1.4 Dangers and Hazards that cannot be eliminated

- Electric shock risk on the electric motor; in case of motor malfunction
- Burn risk because of high temperatures
- Accidental oil leaks with consequent risk of slipping
- Hose breakage and resulting lubricant loss

With oil temperatures exceeding 40/45 °C, it is vital to be extremely careful when handling the metal lances/the hoses and when moving the unit. Avoid direct contact with hot oil and with the filter body.

ALL EQUIPMENT SHOULD BE ALLOWED TO COOL PRIOR TO HANDLING, AFTER IT HAS BEEN IN USE

1.5 Personal Protective Equipment

When operating the unit, personnel must be wearing safety shoes, gloves and goggles. In general, the PPEs to be used according to the activities on the machinery are listed in the following table:



Activity	PPEs
Ordinary operation	Shoes, gloves, goggles, overall
Planned maintenance	Shoes, gloves, goggles, overall

GENERAL WARNINGS

2 Transportation and Storage

2.1 Transportation and Handling Conditions

The unit is shipped in a cardboard box, encased in polyurethane foam.

The packed weight of the HPCM and accessories is 2.5kg.

2.2 Storage

The unit should be stored in a suitable location away from the production area when not in use. The unit should be stored with the caps provided on the ports. This location should not impede any other production or personnel.

TRANSPORT / STORAGE

3 Warranty, Limitations and Disclaimers

Webtec warrants that the products that it manufactures and sells will be free from defects in material, workmanship & performance for a period of 12 months from the date of shipment.

Hardware/Firmware

Should the hardware prove defective during the warranty period, Webtec, at its discretion, will either repair the defective product or replace it with an equivalent product in exchange for the defective unit without charge for parts, labour, carriage and insurance.

Software

Webtec warrants that software will operate substantially in accordance with its functional specification for 12 months from date of shipment provided that the integrity of the operating environment has not been compromised through misuse, inappropriate handling, abnormal operating conditions, neglect or damage (unintentional or otherwise) or the introduction of third party product (software or hardware) that in any way conflicts with the Webtec product.

Eligibility

This warranty extends to the original purchaser only or to the end-user client of a Webtec authorised affiliate.

How to obtain service?

To obtain service under the terms of this warranty, the customer is required to notify Webtec before the expiration of the warranty period and to return the item in accordance with Webtec product return policy. Any product returned for warranty repair must be accompanied by a full fault report specifying the symptoms and the conditions under which the fault occurs. Should Webtec incur additional cost as a result of a failure to complete the appropriate paperwork, an administrative charge may be levied.

Exclusions

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate care. Webtec shall not be obligated to provide service under this warranty if:

a) Damage has been caused by a failure to make a full and proper inspection of the product (as described by the documentation enclosed with the product at the time of shipment) on initial receipt of the product following shipment;

b) Damage has been caused by the attempts of individuals, other than Webtec staff to repair or service the product;

c) Damage has been caused by the improper use or a connection with incompatible equipment or product including software applications.

4. Technical specification

4.1 Performance

Technology	LED Based Light Extinction Automatic Optical Contamination Monitor
Particle Sizing	>4, 6, 14, 21, 25, 38, 50, 70µm
Analysis range	ISO 4406: Code 0 to 25 NAS 1638 Class 00 to 12 AS4059 Rev E Table 1 & 2 Sizes A-F: 000 Please Note: (Lower Limits are Test Time dependent) If system cleanliness is expected to be above 22/21/18 or approx. NAS 12
Calibration	Each unit individually calibrated with ISO Medium Test Dust (MTD) based on ISO 11171, on equipment certified by I.F.T.S. ISO 11943
Moisture & Temperature Measurement	% saturation (RH) and fluid temperature (°C) – Mineral Oil / Diesel version only
Accuracy	±½ ISO code for 4, 6, 14µm ±1 code for 21, 25, 38, 50, 70µm ±3°C ±3%RH

TECHNICAL SPECIFICATION

4.2 Electrical Interface

Supply Voltage	9-36V DC
Supply Current	12V 24V 36V 150mA 80mA 60mA K version 70mA 40mA 30mA NON-K version
Power Consumption	2.2W max
Test Time	Adjustable 10 - 3600 seconds (factory set to 120s)
Data Storage	Approximately 4000 timestamped tests in the integral HPCM memory
Keypad & LCD	6 keys, 128x64 pixels, back-lit graphical display
Communication Options	RS485 MODBUS CANBUS 4-20mA

4.3 Physical Attributes

Dimensions	123mm (H) x 142mm (W) x 65mm (D)
Mounting	2 holes Ø7mm 126mm apart
Weight	1.6kg
Connections	G1 M16x2 hydraulic connection G3 ¼" BSPP Female Port G4 7/16 UNF Female Port
Seal Material	M/N Version – FKM (contact Webtec for any fluids that are incompatible with FKM seals

4.4 Fluid Characteristics

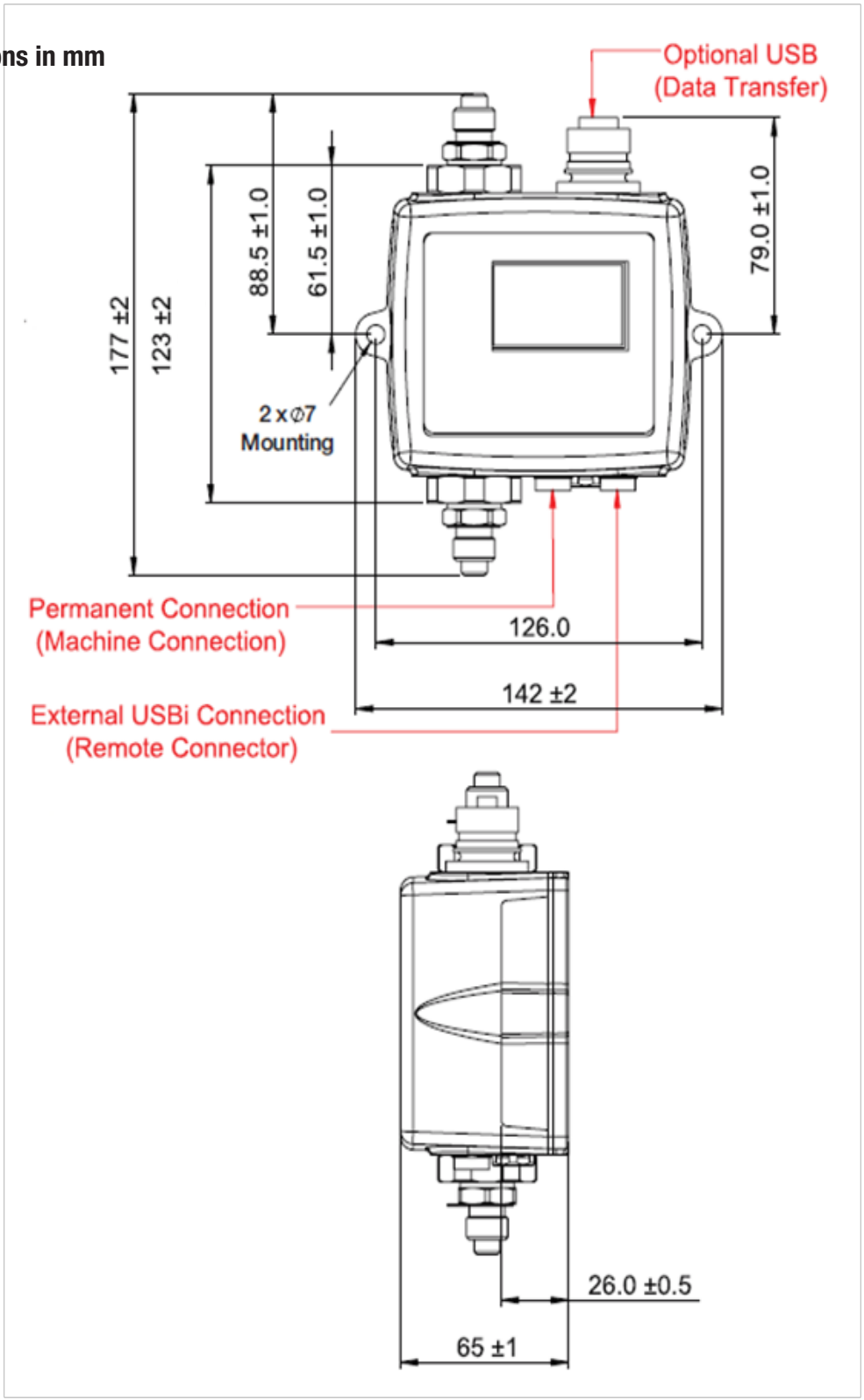
Fluid compatibility	M version - mineral oils, synthetic fluids and diesel
Viscosity	≤ 1000 cSt
Fluid temperature	-25°C to +80°C
Operating Flow Rate	20-400ml/min
Maximum Pressure	420barg static (For high frequency pressure pulse applications contact Webtec)
Differential Pressure	Typically 0.5bar

4.5 Environment

Ambient working temperature	-25°C to 80°C non K version / -25°C to 55°C K version
IP Rating	IP66
IK Rating	IK04

TECHNICAL SPECIFICATION

Dimensions in mm



4.6 Wetted parts list

M Version
Copper Alloy C46400
Stainless Steel
Sapphire (Al_2O_3)
FKM
PTFE
FR4

TECHNICAL SPECIFICATION

5. Product Installation and General Operation

5.1 Installation

Each HPCM supplied consists of the following:
- HPCM
- Calibration certificate
- USB Stick which includes: Product User Guides, LPA-View software, accessory product drivers and product brochures
- Pre-wired 3m cable
- Quick Start Guides

Optional Equipment:
- HPCMUSBi USB adaptor with pre-wired HPCM cable

5.1.1 Physical Procedure

- Decide on tapping points in hydraulic circuit
- Locate the unit mechanically and bolt to desired location using fixing holes provided. The HPCM must be in a vertical orientation, with the oil flowing upwards through it
- Wire back to junction box
- Check flow in acceptable range. There needs to be a differential pressure of more than approximately 0.5bar placed across the HPCM, such that a flow of fluid is generated within the range of the unit.
- If there is no suitable differential pressure available, then a flow controller will be needed. This should be fitted to the drain side of the HPCM (the top fitting).
- Fix mechanically
- Connect hoses or hard pipe from the system
    - There must be no extra restriction placed in the drain hose. Do not have a pipe going to a restrictor to control flow. Any such restrictor must be mounted directly to the HPCM drain fitting. (A)
    - Fluid flow must be from the bottom fitting to the top, following the direction of flow arrow on the product labelling i.e. the bottom fitting is the inlet and the top fitting is the outlet.
- Fit electrical connector, wire back to a junction box.

(A) This is because any length of pipe between the HPCM and a downstream restrictor can act as an accumulator. Any pressure pulsations (for example from a pump) in the feed to the HPCM are then translated into pulsations in flow rate, sometimes leading to flow reversals in time with the pulsations. If the flow is very low this can sweep the same particle backwards and forwards through the sensing volume multiple times, confusing the results.

5.1.2 Electrical Interface

Webtec's separate HPCM-USBi product is available for those wishing to have a simple plug and play solution providing connection of the HPCM to a computer. This section is for those wishing to do their own wiring to the product.

5.1.2.1 Electrical Connectors

The HPCM has two circular connectors located on the lower face of the unit. The USBi product can be connected to either one depending on the installation configuration

PIN	COLOUR	'MACHINE' CONNECTOR	'REMOTE' CONNECTOR
1	Yellow	RS485+/CANL/4-20mA(A)	RS485+
2	Pink	START INPUT	
3	Green	RS485-/CANH/4-20mA(B)	RS485-
4	White	OUTPUT 1	
5	Grey	I/O COMMON	
6	Brown	OUTPUT 2	
7	Blue	DC 0V	DC 0V
8	Red	DC +POWER	DC +POWER

5.1.2.1.1 Remote Connector

The ``remote connector" is intended for temporary connection of an external communication device e.g. HPCMUSBi so as to allow data download, remote control or diagnostics using the LPA-View software.
This is the circular connector furthest from the hydraulic connection

This carries RS485 data and can also be used to power the unit temporarily in the event of a system being shut down, thus no longer providing power to the unit.

This connector doesn't send alarm signals. If you require a USBI to send alarm signals it has to be connected to the machine connector.

5.1.2.1.2 Machine Connector

The ``machine connector" is intended for permanent connection to the PLC / machine that powers the HPCM during normal operation. It has power connections, a start signal input, two relay outputs, and a data pair that can be set to RS485, CANbus or 4-20mA signaling modes.

This is the circular connector closest to the hydraulic connection.

NOTE: If CANBUS or 4-20mA option has been selected, standard communication with an RS485 adapter (e.g. USBI) on this port is no longer available. The right hand port (remote connector) should be used if temporary connection is required.

NOTE: Start signal and relay outputs only apply to this connector.

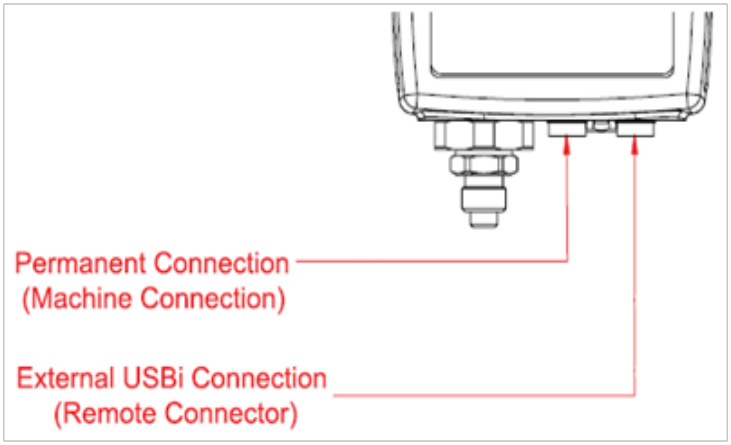


Figure 5.1 Connector Orientation

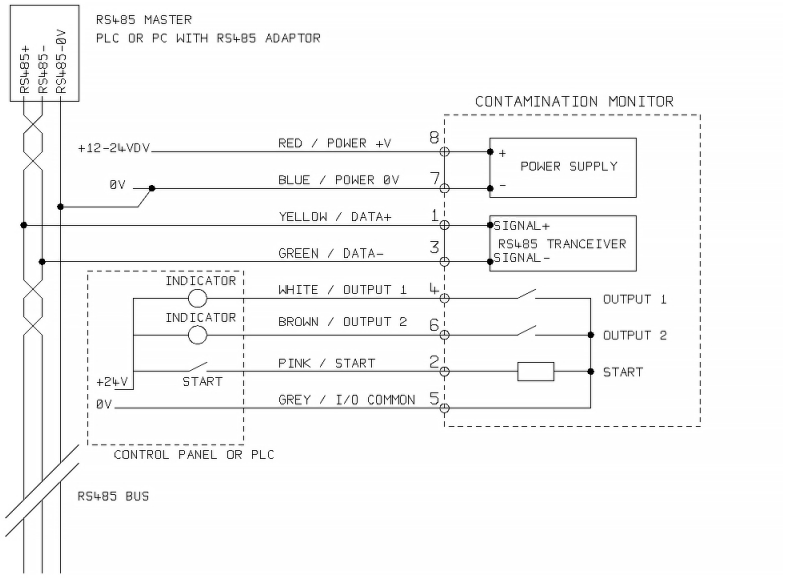


Figure 5.2 Machine Connector
External Wiring Example

5.1.2.2 DC Power

DC power is connected to pins 7 and 8 of either circular connector (Red and Blue if using the pre-wired cable). All the other signals are optional.

Item	Minimum	Maximum
Voltage	9v DC	36V DC
Current		200mA

5.1.2.3 Machine Connector - Serial Interface

An RS485 or CANbus interface can optionally be connected to pins 1 and 3 (yellow and green). This can be a PLC running customer software, or a PC with a RS485 adaptor running the supplied LPA-View software. To provide a reference the RS485 0V connection should also be linked to the HPCM 0V.

The standard HPCM control protocol is Modbus RTU. Modbus is a freely available open standard for industrial control. Adapters are available to interface to other industrial control busses. The standard LPA-View software from Webtec itself uses Modbus to communicate with the HPCM, but it is also possible for customers to implement their own controllers (section Modbus).

The CANbus protocol can also be used, see section 5.4.2.

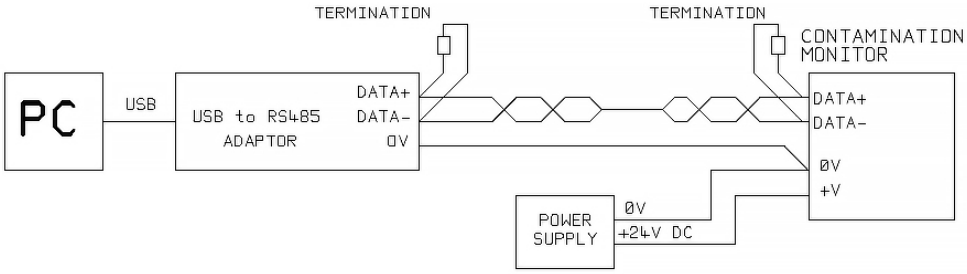


Figure 5.3a PC Control Example

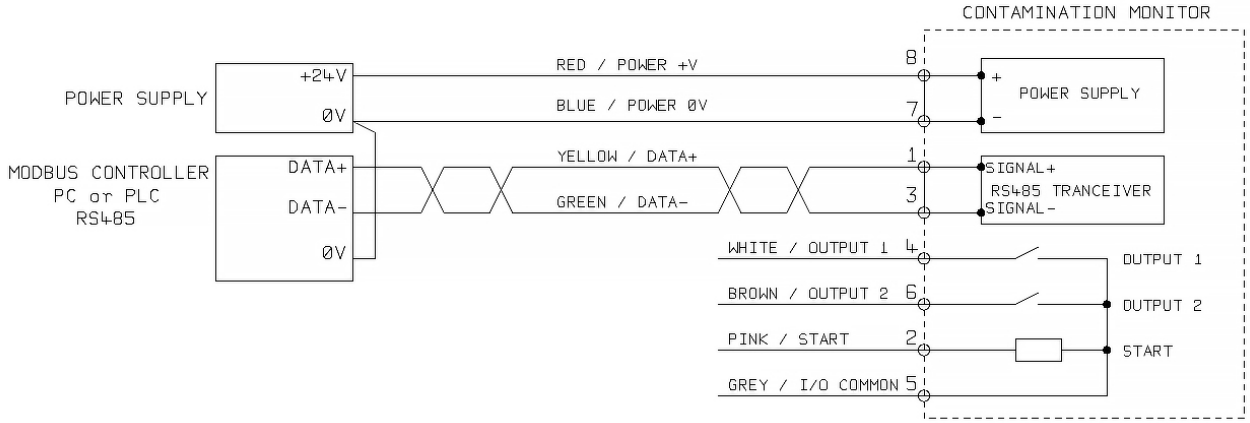


Figure 5.3b Modbus Controller Example

Figure 5.3a shows a single HPCM linked to a PC, using a USB-RS485 adaptor. Figure 5.3b shows a slightly different method. 100 Ohm termination resistors should be fitted as shown for long cables, for example over 10m. Twisted pair wiring should be used for any length over 2m.

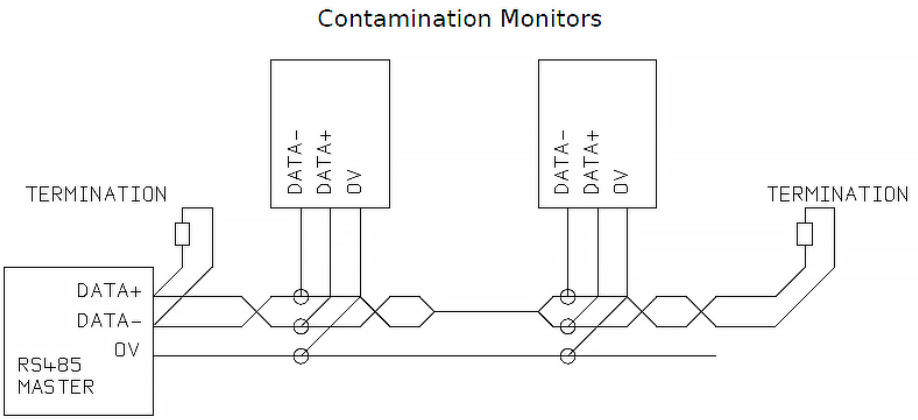


Figure 5.4 Multi-Drop Network Example

Figure 5.4 shows how to connect two or more HPCM devices to a multi-drop RS485 network. Any termination resistors should be fitted to the network cable ends only. Spurs off the main RS485 bus should be kept as short as possible, e.g. below 2m. Normally the pre-wired 3m cable available for the HPCM would be used, with a junction box to connect to the RS485 trunk. Either individual DC supplies can be used to power each HPCM, or a single supply run through the trunk cable.

5.1.2.4 Switched Input and Output Signals

The HPCM has one switched input and two switched outputs. These can be used instead of, or in addition to, the RS485 interface for command and control. The RS485 interface is more flexible but requires more software work if LPA-View is not used (e.g. control from a PLC). An alternative is to control the HPCM via these switched I/Os, either from a PLC or using a manual switch and indicators.

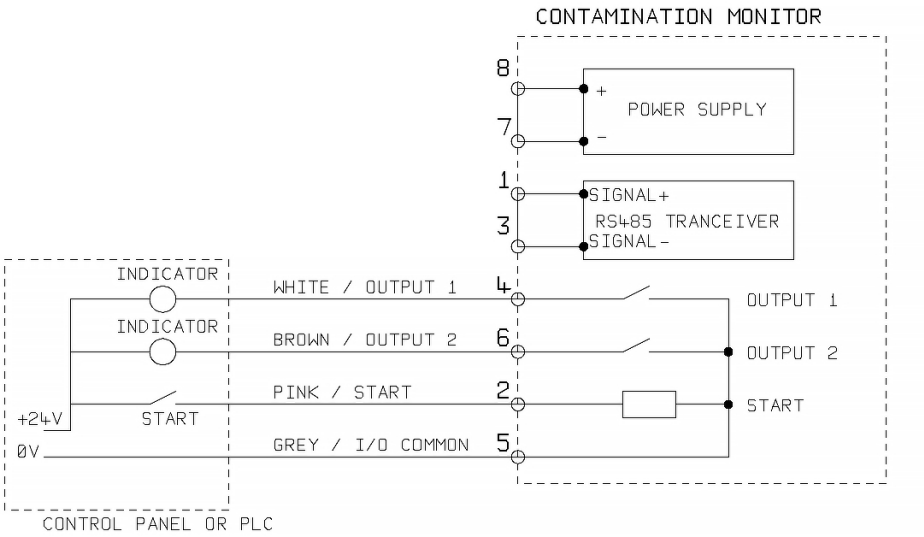


Figure 5.6 Switched I/O Signals

In order to reduce wiring the input and outputs all connect together on one side (see Figure 5.6). However they are optically isolated from the rest of the system so can be used to switch unrelated signals.

5.1.2.5 Start Signal

The “start signal” is an opto-isolated input that can be used to start a test, it can be used to ensure testing only occurs when the hydraulic system is running. For example, the start signal could be wired to go on and off with the main hydraulic pump or with a solenoid valve that allows fluid flow. That way the log does not fill up with invalid tests that were carried out with no flow.

This could be from a push button or a PLC output. The input accepts AC or DC signals, typically derived from the DC supply voltage. The exact function of this input is determined by the Test Mode setting, see section 8.1.1.3.

Item	Minimum	Maximum
Voltage	9V DC	36V DC
Impedance	10k Ohms	

- When the START signal transitions from OFF to ON, the unit will start a new test or restart any test in progress.
- At the end of the test, the state of the START signal is checked
- If the START signal is still on at the end of a test, another test is started. So that testing continues while the START signal is held on.
- The switching off of the start signal will operate as a STOP command. That is, it will abort any test in progress. It will continue to show and report the previous result.
- This new operation mode applies whether or not continuous testing is enabled.
- So for example if “continuous testing” and “stop testing when clean” are both enabled, and if the start signal is being held on throughout testing, then EITHER the start signal vanishing OR a clean result can terminate testing.

- This is not the same thing as the “start signal delimited test” option (“start signal defines test duration” in user settings when enabled). This is for using the start signal to control the duration of each *single* test, only.

Other ways to test are:

- From the HPCM front panel START button, if fitted (K Keyboard option)
- Via LPA-View or PLC Modbus command
- Periodic automatic testing according to a programmed test mode

5.1.2.6 Alarm Outputs

These are opto-isolated switches that can be used to signal external indicators, PLC inputs or other equipment (e.g. pump on/off control).

The exact function of these outputs is determined by the Alarm Mode setting.
The outputs are “voltage free” contacts that can switch AC or DC signals up to 36V nominal (60V absolute maximum peak voltage).

Item	Minimum	Maximum
Voltage		36V DC
Current		0.5A

5.1.2.7 4-20mA Connection

The two 4-20mA outputs are sourced from the main supply voltage DC+. These may be connected to the 4-20mA inputs of a process indicator or a PLC. The 0V connection is then also normally connected to the PLC 0V.

The 4-20mA outputs can be converted to 0-5V outputs by connecting a 250 ohm resistor between each output and 0V. Similarly they can be converted to 0-10V outputs by connecting 500 ohm resistors.

For details of how the test results are represented by the 4-20mA signals see section 5.4.3.

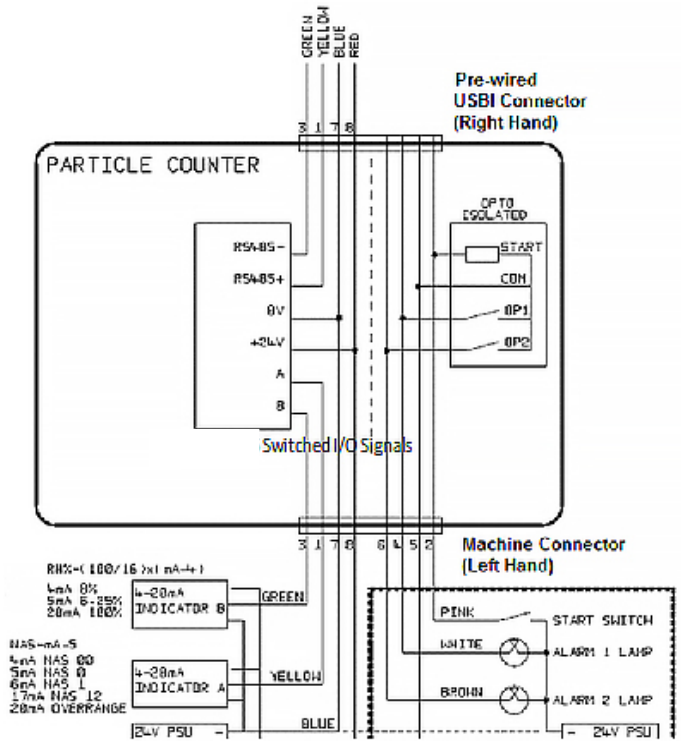


Figure 5.7 Switched I/O Signals

5.1.3 Hydraulic Connection

1 High or Low Pressure Parallel Connection

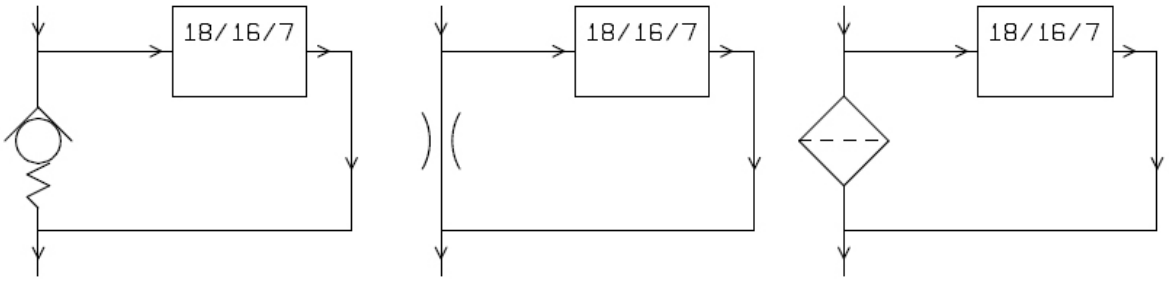


Figure 5.8 HPCM working pressure generated by hydraulic component

2 Low Pressure, Off-Line Operation

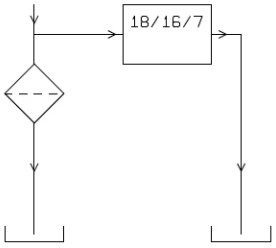


Figure 5.9 HPCM working pressure generated by hydraulic component

3 Very Low Flow Systems

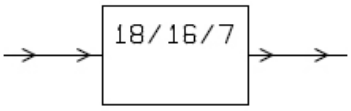


Figure 5.10 Entire system flow rate is within the range of the HPCM

5.1.3.1 Flow Rate

For the majority of systems, a differential pressure of a few Bar will generate an in-range flow for an HPCM connected using two 1.5 meter lengths of microbore pressure hose. The required differential pressure can be obtained by taking advantage of an existing pressure drop within the system. Alternatively one can be created by inserting a check valve. The HPCM can then be connected across this differential pressure source.

5.1.3.1.1 Detailed Calculations

In general the flow rate of fluid through the HPCM needs to be kept within the range of the unit (see hydraulic specification). The HPCM measures the flow during operation, so this can be used to check that the flow is correct. A flow that is out of range will be indicated by a fault code.
Note: Results taken with out-of-range flows are not logged.

The flow is entirely generated by the differential pressure between the ends of the pipes used to connect the HPCM. The pressure needed to generate an in-range flow can be estimated by assuming a target flow, and determining the resulting pressure drop across the HPCM and connection piping. Use Figure 5.11 to lookup the HPCM pressure drop, and manufacturers' data to lookup the piping pressure drop at the desired flow. The sum of these two pressures is the pressure needed.

The user connects the HPCM between two points in the hydraulic circuit that have this pressure difference.
In order to use the graph:

- Determine the working viscosity of the fluid, e.g. 30 cSt
- Decide on a desired flow rate. 200ml/minute is normally used since this is in the middle of the HPCM flow range. But 100ml/minute is also suitable and uses less oil
- Use the figure 5.11 to look up the pressure drop, across the HPCM ports, at this flow rate and viscosity. E.g. at 30cSt and 200ml/minute, this is 0.4 Bar. The maximum and minimum allowed differential pressures can also be determined using the 400ml/min and 20ml/min lines, respectively.

- Determine the additional pressure drop caused by the piping used to connect the HPCM. This may be negligible for 1/4 inch piping and over, but is very important for microbore hoses. This information can be found in the manufacturers catalogues. In the case of microbore hoses, at 30 cSt these have a pressure drop of around 10 Bar per meter per lpm of flow. So a 2m total hose length would add a pressure drop of 2 × 10 × 0.2 = 4 Bar. (So in this case the pressure-flow relationship is mainly dependent on hose resistance).

- Add the HPCM pressure drop to that of the hoses, e.g. 4 + 0.4 = 4.4 Bar

When the required pressure drop has been found:

- See the figures at the start of this section for examples of where the HPCM could be connected

- If there is a pair of connections in the hydraulic circuit that operates with a differential pressure near to that calculated, then the HPCM can be connected there

- Alternatively, create the pressure drop by modifying the hydraulic system. For example, insert a check-valve in the circuit with a 4 bar spring. The “component” could also be a filter, a restrictor or even a piece of piping if it has a suitable pressure drop across it.

- If none of these options is feasible, then an active flow controller will likely be needed.

- Otherwise connect the HPCM across the points identified; taking care to maintain an upward flow of oil through the unit (this reduces trapped air).

- Of course in a real system the pressure and viscosity will vary with temperature and operating conditions. But since the working flow range of the HPCM is very wide, this should not be a problem provided it remains within range. On the graph the area between upper and lower lines represents the usable operating region for the HPCM, with the middle line being ideal. The differential pressure and the viscosity can vary from the ideal, provided the system stays within the upper and lower lines. This ensures the flow stays within the working range of 20 - 400 ml/min. It can be seen that the unit will accommodate a 20:1 variation in either viscosity or differential pressure during operation.

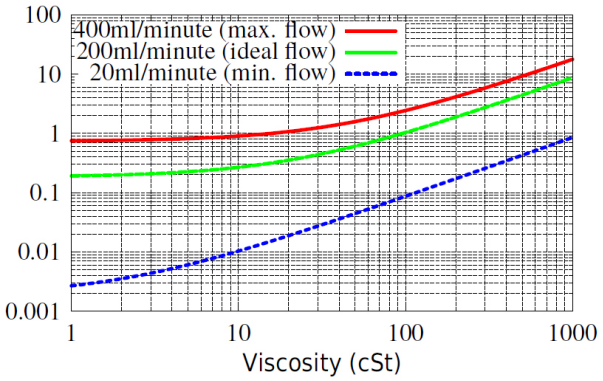


Figure 5.11 Differential Pressure vs Fluid Viscosity, for various flow rates

5.1.3.2 Manual Flow Control

Another possibility is to fit a simple manual flow control (flow restrictor) to the outlet of the HPCM.

- This should only be done where the available pressure is less than twice the maximum value calculated. This is because the small orifice size needed to control the flow from a pressure larger than this has a risk of blockage.
- The flow controller must be fitted to the outlet only. If fitted to the inlet it will have a filtering effect.
- The flow controller must be fitted directly to the HPCM outlet port.

5.2 General Operation

5.2.1 Physical Checks

- Oil leaks on and around the unit
- Fatigue in hoses and pipework that might then leak when under system pressure

5.2.2 Front Panel Operation

5.2.2.1 Status LED

All HPCM2 versions have a multi-colour indicator on the front panel, which is used to indicate the status or alarm state. HPCM2 versions also have a screen that changes colour. The alarm thresholds can be set from LPA-View via the serial interface.

Figure 5.13 Front panel of K version

Colour	Indication
Green	Indicates that the test result has passed, i.e. none of the alarm thresholds were exceeded
Yellow	Indicates that the lower cleanliness was exceeded, but not the upper one
Red	Indicates that the upper cleanliness was exceeded
Blue	Indicates that the upper water content limit was exceeded
Red/ Blue Alternating	Indicates both cleanliness and water content upper limits exceeded
Violet	Indicates that the upper temperature limit was exceeded
Red Flashing White	Various fault codes can be indicated by the LED turning red and then flashing white a number of times

Please note: If the codes seem confusing, note that a given colour will only ever be seen if the corresponding limit has been specifically set by the user. So for example if a maximum temperature limit has not been set, the violet indication will never be seen. If all that is wanted is a “green or red” light, that can be arranged by simply setting only the cleanliness threshold maximum limit.

If the upper temperature alarm is set, this takes priority over the Contamination and Water alarms. In the event of an over temperature condition, the LED will turn violet only, whether or not there is also a contamination or water alarm condition. The rationale is that an over-temperature condition could be immediately catastrophic for the hydraulic system.

5.2.2.2 Front Panel Operation

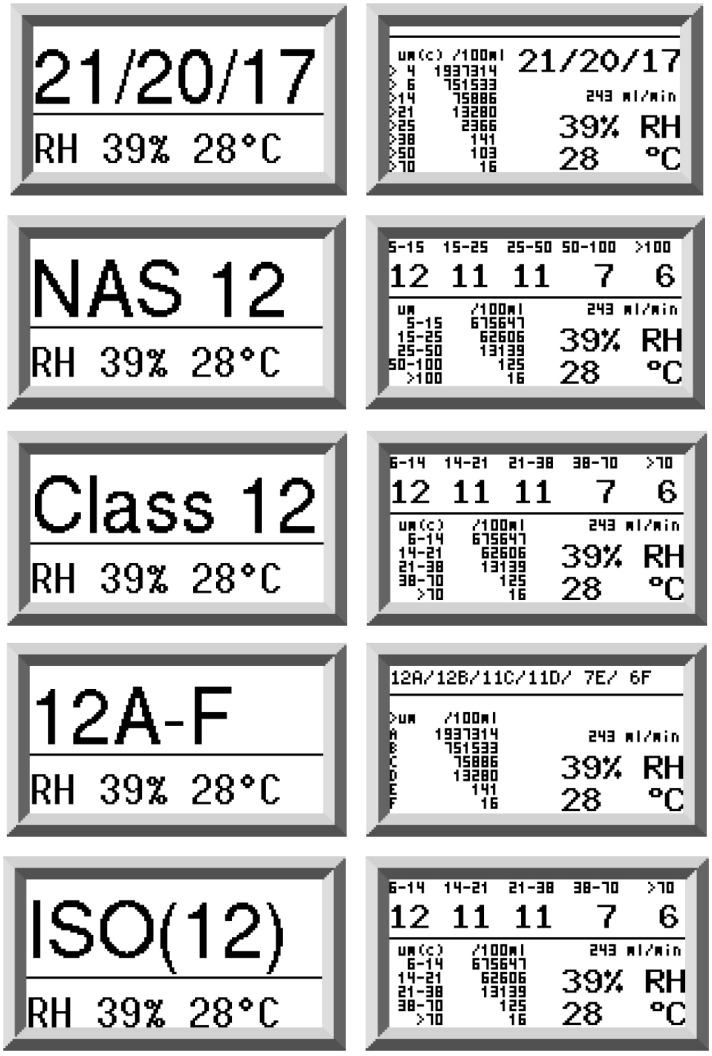
5.2.2.2.1 Result Display

HPCM-K models have a 6 button keypad and a small graphical LCD. This allows the display of the test result (current cleanliness level, with water content and temperature if applicable).

The graphical format allows a full display of all codes of the standards supported.

The unit powers up in “Display Mode”. This displays the test result in the selected format. The table below shows those available.

The screenshots in the right column are the “detailed” version of the display additionally showing the particle counts and flow rate. The particle sizes and count representation are automatically matched to the selected format.



There is also a ``History” screen which shows the last 10 results.
The operator can switch between these screens using the ∨ and ∧ keys.

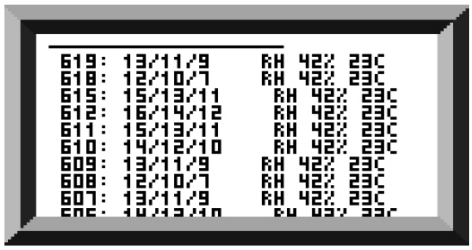


Figure 5.14 History Screen

The progress of a test is denoted by the horizontal line; it grows from left to right as the test progresses. When it reaches the right hand side a new result is generated.

5.2.2.2.2 Diagnostics Display

Press < or > to show the diagnostics displays (used when diagnosing problems) shown in figure 5.15. Then switch between the diagnostics screens using the ∨ and ∧ buttons.

Completion shows a number from 0 to 1000, indicating the test progress.
FLOW ml/min provides an approximate indication of flow rate, updated after each test.

NOTE: This is not a calibrated flow meter and is for indicative purposes only.

This can be helpful when installing the unit or checking operation, to ensure that the flow rate is within the limits of the unit. The other items are mainly of use to assist in support when reporting problems.

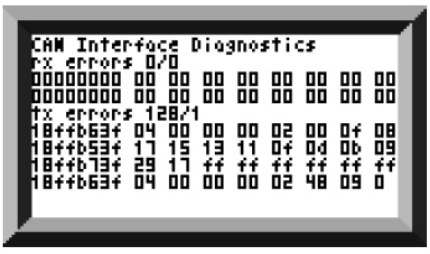
The STATUS line shows the current state of the unit. Any errors such as LOW FLOW will also appear here (corresponding to the front panel LED fault codes).

The second screen shows diagnostics relating to Modbus serial communications traffic. External Comms Errors are those between a connected PC and the HPCM. Internal Comms Errors are internal to the unit, showing communications between the HPCM keyboard/display circuit board and the sensor itself.

The third screen shows diagnostics related to CAN bus communications. For more details refer to the separate HPCM CAN bus manual. There is also a ``History" screen which shows the last 10 results. The operator can switch between these screens using the ∧ and ∨ keys.

General

Modbus



CAN Bus

Figure 5.15 Diagnostics Screens

5.2.3 HPCM removal and Product Maintenance

When removing the HPCM from the system ensure the system pressure is shut off from the HPCM.

- If this doesn't solve the problem then try using Iso-Propyl Alcohol or Petroleum Ether, flushing in the standard and reverse flow direction.
- If this doesn't solve the issue then send to Webtec for investigation.

5.3 HPCM Control

The HPCM can be controlled using the remote control facility included in the LPA-View software package, installed on a computer. Alternatively customers can use their own computer software.
Since the HPCM includes a built-in data logging memory, operators can make use of the remote control facility in one of two ways:

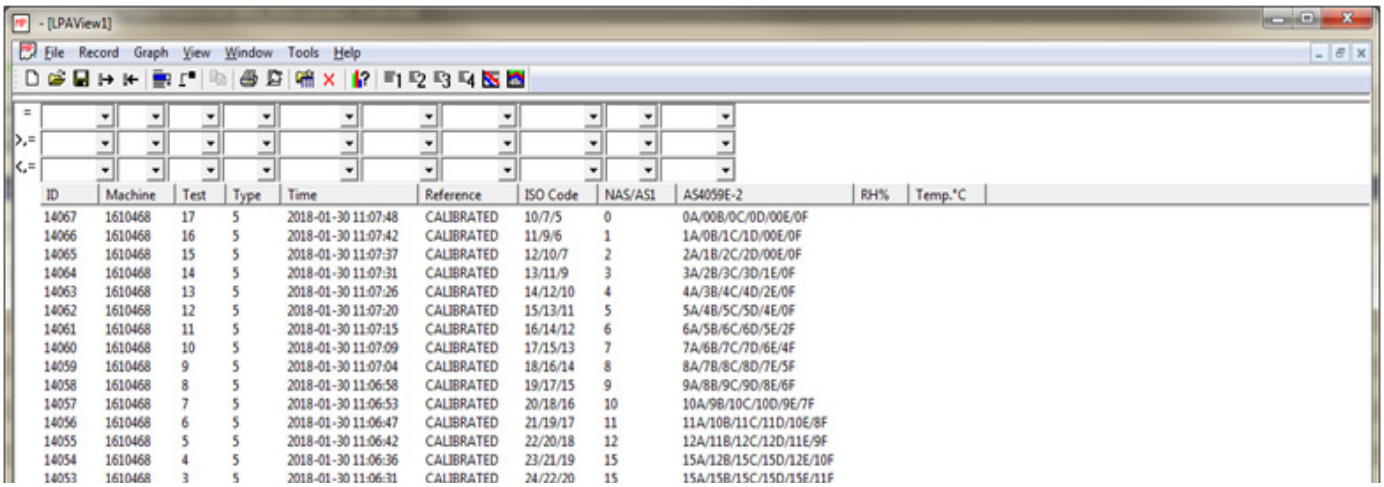
– Direct Online Operation
The HPCM is permanently connected to a computer while tests are carried out. The operator can set parameters, type a label and initiate the test. They can then monitor the progress of each test. Each test result is displayed and downloaded into the test database as it is completed.

– Disconnected Operation
Here the HPCM operates as a standalone item, performing tests on a schedule or under external command from a control system. If a permanent record of the results is needed, an operator can connect a computer and use LPA-View to download the accumulated test data. The HPCM can hold up to 4000 tests in the memory.

5.3.1 Computer Connection

The connection is made using an RS485 adaptor connected to the computer or control device.

The HPCMUSBi is included as a pre-wired solution for USB (all modern laptops and PCs). Make the connection, start LPA-View running and then apply power to the HPCM.



ID	Machine	Test	Type	Time	Reference	ISO Code	NAS/AS1	AS4059E-2	RH%	Temp.°C
14067	1610468	17	5	2018-01-30 11:07:48	CALIBRATED	10/7/5	0	0A/00B/0C/0D/00E/0F		
14066	1610468	16	5	2018-01-30 11:07:42	CALIBRATED	11/9/6	1	1A/0B/1C/1D/00E/0F		
14065	1610468	15	5	2018-01-30 11:07:37	CALIBRATED	12/10/7	2	2A/1B/2C/2D/00E/0F		
14064	1610468	14	5	2018-01-30 11:07:31	CALIBRATED	13/11/9	3	3A/2B/3C/3D/1E/0F		
14063	1610468	13	5	2018-01-30 11:07:26	CALIBRATED	14/12/10	4	4A/3B/4C/4D/2E/0F		
14062	1610468	12	5	2018-01-30 11:07:20	CALIBRATED	15/13/11	5	5A/4B/5C/5D/4E/0F		
14061	1610468	11	5	2018-01-30 11:07:15	CALIBRATED	16/14/12	6	6A/5B/6C/6D/5E/2F		
14060	1610468	10	5	2018-01-30 11:07:09	CALIBRATED	17/15/13	7	7A/6B/7C/7D/6E/4F		
14059	1610468	9	5	2018-01-30 11:07:04	CALIBRATED	18/16/14	8	8A/7B/8C/8D/7E/5F		
14058	1610468	8	5	2018-01-30 11:06:58	CALIBRATED	19/17/15	9	9A/8B/9C/9D/8E/6F		
14057	1610468	7	5	2018-01-30 11:06:53	CALIBRATED	20/18/16	10	10A/9B/10C/10D/9E/7F		
14056	1610468	6	5	2018-01-30 11:06:47	CALIBRATED	21/19/17	11	11A/10B/11C/11D/10E/8F		
14055	1610468	5	5	2018-01-30 11:06:42	CALIBRATED	22/20/18	12	12A/11B/12C/12D/11E/9F		
14054	1610468	4	5	2018-01-30 11:06:36	CALIBRATED	23/21/19	15	15A/12B/15C/15D/12E/10F		
14053	1610468	3	5	2018-01-30 11:06:31	CALIBRATED	24/22/20	15	15A/15B/15C/15D/15E/11F		

Figure 5.16

To access the Remote Device facility in LPA View, press the Remote Control button (Figure 5.17) on the toolbar. The Connect dialogue will then appear (Figure 5.18).

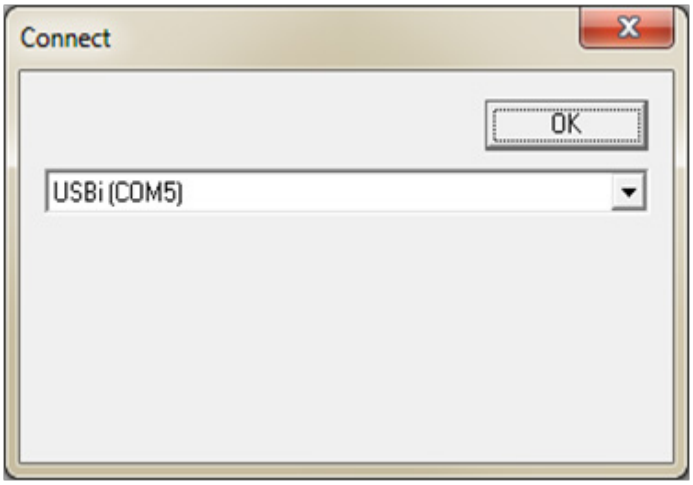


Figure 5.18

The first time that this is done, the correct communications port (COM port) on the computer has to be selected, as detailed below.

The program scans the computer for available ports, and puts them in a list to choose from - this list is in the box above the Connect button. Press the arrow on the right hand side of this box and choose the connection on your computer.

All working communication ports of the computer are available for selection. Select the one used to connect the HPCM, and then press OK. If you are unsure which port is correct, the device name should be next to the COM port number. When communication has been established successfully, the remote control dialogue will appear. After a successful connection, the COM port will be remembered for next time and will appear preselected in the dialogue. If no COM ports appear, please refer to the fault finding section the manual

5.3.2 PC Software Operation

The Remote Control dialogue allows an operator to manually control the HPCM from a laptop, using the LPA-View software. It can also be used to download test results that have accumulated during autonomous (disconnected) operation.

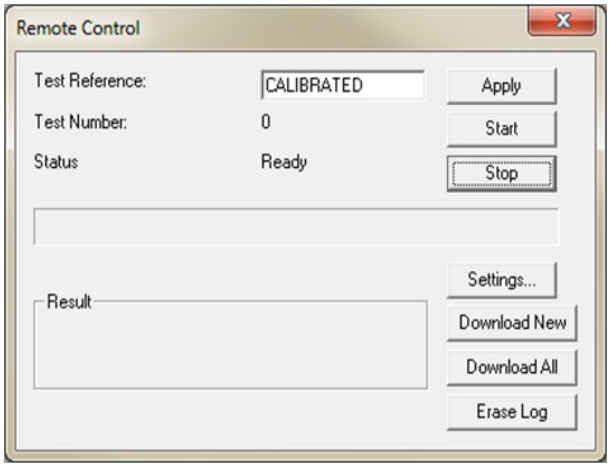


Figure 5.19

To perform a test, first optionally edit the Test Reference and press Apply to register the new value. This is a descriptive label which can be used to identify or group the test later (along with the test number and test time/date). An example would be a machine number or customer name. The Test Reference can be up to 15 characters in length.

When connected the HPCM status should show “Ready”. The operator can then press the Start button to begin the test. The progress bar shows how much of the test has been completed.
The test can be abandoned at any time by pressing the Stop button. If the Start button is pressed during a test, then the current test is abandoned and a new one started. When the test has finished, the Result area will display the contamination level in the set format and water content and temperature (if applicable).
After a test the Test Number is automatically incremented and the status of the test is displayed. If the status is Ready then the operator can press the Start button again to begin a new test.
It is also possible to configure the HPCM to automatically begin another test, after an optional delay. In this case the status will be Testing or Waiting.

The HPCM incorporates a data logger, so previous test results can be downloaded into the test database using the Download New and Download All buttons. The difference between these is that Download New only transfers results that have never been downloaded before. Download All transfers all results that are stored in the HPCM. Erase Log deletes the test results from the memory of the HPCM.
When the user has finished operating the HPCM the dialogue can be dismissed using the close control (the “X” at the top right corner of the dialogue) or by pressing the Esc key. Pressing the Settings... button brings up the Remote Device Settings dialogue.

5.3.3 Settings

The HPCM can be reconfigured using the Remote Device Settings dialogue. This is normally done as part of the installation or commissioning process.

After making any changes, pressing the OK button will update the HPCM with the new settings. Or press Cancel to leave the settings as they were.

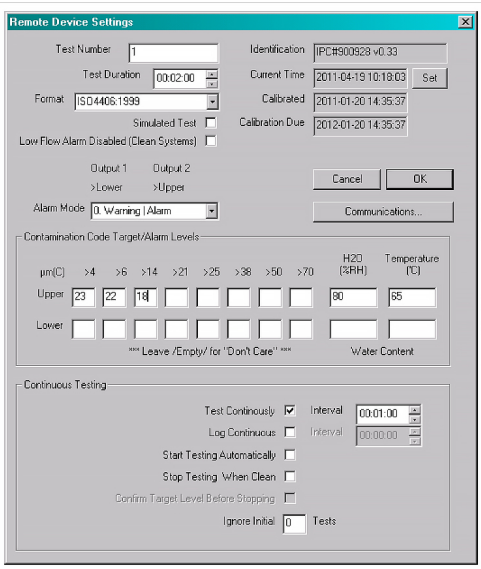


Figure 5.20

NOTE: The HPCM has been designed to be a very flexible product, so has a wide range of settings and operating modes. However the shipped defaults are suitable for most applications and many users can skip this section. Actual operation is straightforward even when advanced settings are used during initial configuration.

NOTE: Some items may be missing depending on the options fitted to the HPCM.

5.3.3.1 General

Some general information about the connected HPCM unit is available. The Identification shows the HPCM serial number and software version. The serial number, together with the test timestamp, uniquely identifies the test record. These two parameters are the ones used to avoid duplication of test records.

Current Time shows the time set on the HPCM. It is important that this is correct since this is used to timestamp the tests. Pressing the Set button automatically synchronizes the HPCM time to that on the computer.

The calibration area displays the date last Calibrated and the next Calibration Due date.

5.3.3.2 Test Number

The Test Number can be used to help identify a test within a sequence. However it is automatically reset when the HPCM is powered up, so instead relying on the timestamp (date and time of test) and test reference is preferred.

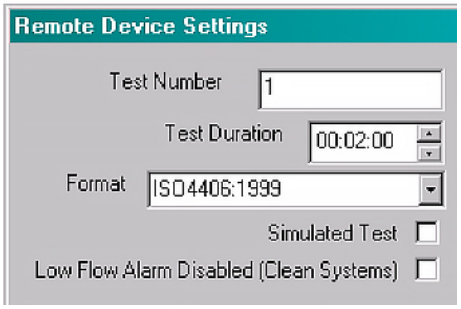


Figure 5.21

NOTE: if the HPCM is power cycled at any point then the test numbering sequence automatically resets and begins again.

5.3.3.3 Test Duration

The length of the test is controlled by the Test Duration.
The factory set value of 2 minutes is suitable for most applications, but the user is free to set a different value. Shorter times will make the HPCM more responsive to short-term fluctuations in contamination level. It will also result in less consistent results for the large particle sizes and clean systems, due to statistical fluctuations in the number of particles counted.

Longer tests will allow more “stable” results in very clean systems and for the larger particle sizes, since there will be a larger total number of particles counted during the test. This means that any fluctuations have less of an effect on the test result.

5.3.3.4 Result Display

Use the selector to choose the preferred display Format (ISO, NAS etc.). This selection is not just cosmetic since it also determines how the cleanliness alarm targets are to be interpreted, if these are used.

5.3.3.5 Simulated Test

This setting can be used when there is no flow available but communications need to be tested.

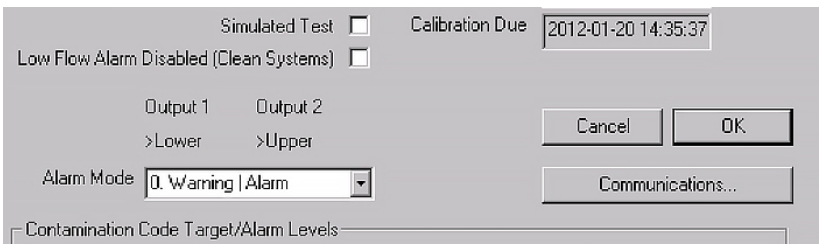


Figure 5.22

5.3.3.6 Low Flow Alarm Disabled (Clean Systems)

It is worth reinforcing that the primary function of the product is to produce a measurement of cleanliness, and not act as a flow meter. If the unit produces a contamination measurement, then the flow rate is sufficient enough for it to do so.

The HPCM needs particles to pass through the flow cell to calculate flow, the dirtier the system is, the more statistically accurate the flow output becomes.

Conversely, when placed on a very clean system the unit can have difficulty in working out the flow due to the very low number of particles passing through the flow cell. To overcome this, the test has to fulfil certain conditions to create a valid result.

If the low flow alarm has been disabled there must be a minimum of 20 particles >4micron seen during the test for the flow reading to be shown and the test result to be valid.

If there are less than 20 particles >4micron during the test then the HPCM will alarm/fault code even if the low flow alarm has been disabled.

Note: If the low flow alarm has been disabled, it is preferred that the HPCM is installed in such a way that if the system is shutdown (zero flow) the HPCM is also shut down so as not to measure stagnant fluid and provide erroneous readings.

It may be necessary that the low flow indicator is turned off if filtration is below 10um (ISO 14/12/10 (NAS Class 4)), see figure 5.22 for location.

5.3.3.7 Continuous Testing

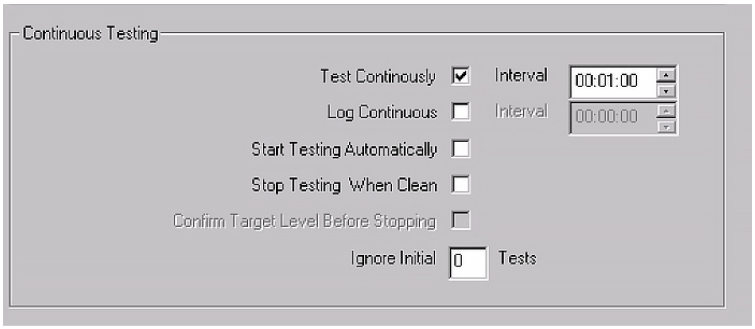


Figure 5.23

In the Continuous Testing area are settings which control how the HPCM decides when to perform and log a test. Selecting Test Continuously makes the HPCM automatically repeat the test, according to the specified Test Interval.

1. Setting an interval longer than the test duration; results in the test being repeated upon each expiry of that interval. For example, setting a Test Duration of 1 minute and a Test Interval of 10 minutes, results in a 1 minute test performed every 10 minutes NOTE: Test time is part of interval time
2. Setting the interval to a value less than the Test Duration (for example zero); results in a new test being started immediately after a test finishes.

Log Continuous controls whether tests are logged during continuous testing. This is to avoid the test log being cluttered by potentially large numbers of unwanted test results. If Log Continuous is not selected, then only the “final” test in a sequence is logged (see Alarm Modes section and “Stop Testing When Clean” below).*

If continuous logging is used, then the Log Interval can be set to control the proportion of tests that are actually logged. For example the HPCM could be set to test every 10 minutes, but only log a result hourly. The log interval, test interval and test duration are distinct parameters that work together to control the test and data logging. So that, a test duration of 2 minutes, a test interval of 10 minutes, and a log interval of 1 hour could be individually set. This would result in 2 minute long tests, repeated every 10 minutes, with a test logged hourly.
NOTE: the log interval must land on a test interval or an error will occur, for example the test interval cannot be 2 minutes and the log interval 3 minutes.

Stop Testing When Clean- This is a feature intended for cleaning rigs or “filter trolley” type applications. The HPCM continues testing until the fluid is “clean”, at which point an alarm is signaled and testing stops.

Ignore Initial Tests- on start up the number selected here is the number of tests that are ignored before results are logged. This is designed for systems that are particular dirty or turbulent on startup and it allows the system to stabilize.

Confirm Target Level before Stopping- this helps to ensure that a test sequence is not terminated too soon, when there are still a few large particles in the system. When selected, the number in the box is how many successive “clean” results are needed before testing halts.

* This feature is intended for a “Filter Trolley” type application where system runs a pump until the oil is sufficiently clean. Typically only the final “clean” result requires logging.

5.3.3.8 Changing Communication Protocols

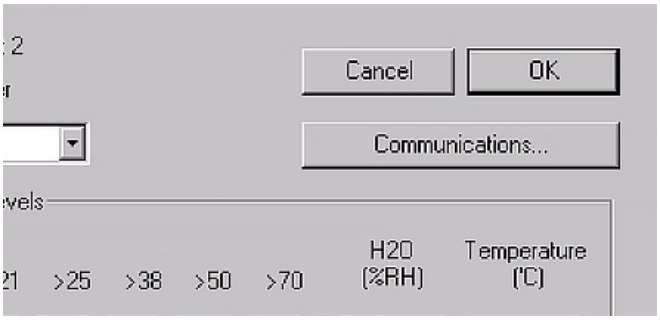


Figure 5.24

Selecting the communication button allows you to change how the HPCM communicates. See figure 5.25 for the options.

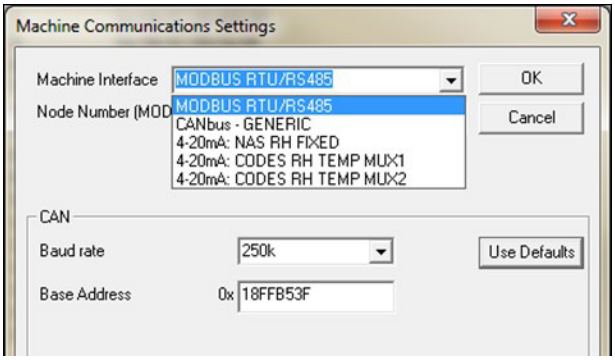


Figure 5.25

Selecting a machine interface sets the output type for the machine connector, for example selecting CANbus means that you can no longer use the machine connector to communicate in Modbus (the default). If you wish to change back or to a version of 4-20mA then you have to connect to the HPCM via the Remote Connector.

5.3.3.9 Alarms

The HPCM has two switched “alarm” outputs that can be used to signal external equipment in various ways, according to the test results and the alarm settings. There is also a multi- colour front panel light which indicates how the result compares to the set alarm thresholds.

The alarm settings are comprehensive and flexible, allowing the HPCM to be used in many different scenarios.

5.3.3.9.1 Alarm Levels

The various alarm thresholds are set in the Contamination Code Target / Alarm Levels area of the dialogue.
Alarms can be set on combinations of cleanliness codes, water content and temperature. The available codes, and their interpretation, vary according to the set test Format. For example it is possible to set a threshold of “NAS 11” or “ISO 18/16/15” or “AS4059E 8B-F”, etc.

In general there are upper and lower limits that can be set for the cleanliness level, also for water content and temperature if applicable. An alarm, if enabled, will become active if any of the associated (upper/lower) limits are exceeded. However if a field is left empty (blank) this is interpreted as a “don’t care” setting.

The Upper Alarm is exceeded if the 4µm count is greater than ISO code 23, or the 6µm greater than ISO code 22, or the 14µm count greater than code 18, or the water content is greater than 80% RH, or the temperature is greater than 65°C. The lower alarm is never triggered since all the settings are empty.

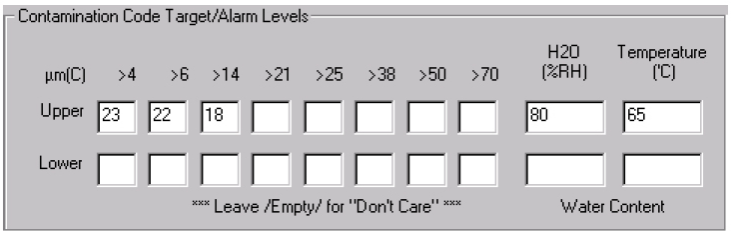


Figure 5.26

ISO4406:1999 Alarm Levels

ISO4406:1999 represents cleanliness using codes for the number of particles greater than 4, 6 and 14µm. These codes can be used as limits for the alarms by selecting the ISO4406:1999 test Format and then entering values as required. As an extension to ISO4406:1999 it is also possible to specify codes for the other measured sizes too. If this is not needed then the entries can be left blank.

NAS1638 Alarm Levels

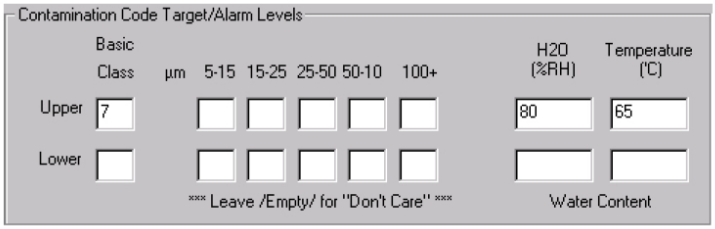


Figure 5.27

NAS1638 can be used by selecting this as the test Format. The headings and boxes for the available settings change appropriately. NAS1638 represents the overall cleanliness level as a single code, this being the highest of the individual codes generated for each defined particle size. Hence we have the option of setting a limit on this overall contamination class (the Basic Class), or we can set individual limits on any combination of the classes for the defined particle size ranges.

AS4059E Table 2 Alarm Levels

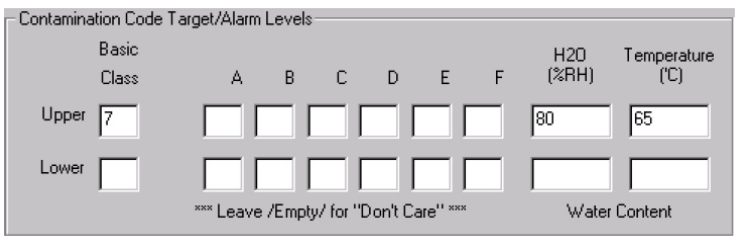


Figure 5.28

AS4059E Table 2 uses letters instead of numbers to indicate the particle size range, so the settings are labelled appropriately. The standard specifies ways to represent a cleanliness level using only a subset of the available particle sizes, for example B-F. The user can achieve this by only entering settings for the sizes desired, leaving the others empty. So a limit of AS4059 7B-F could be represented simply by entering a value of 7 for B, C, D, E and F.

AS4059E Table 1 / ISO11218 Alarm Levels

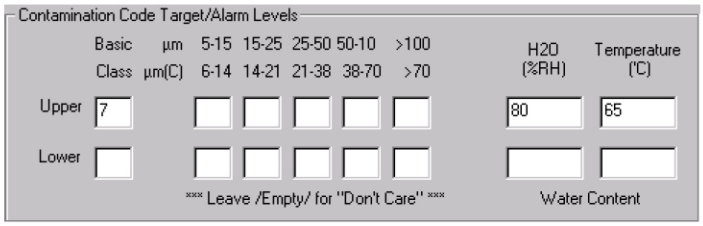


Figure 5.29

These two standards are similar except for terminology and reporting format. The actual numeric sizes and class thresholds are the same.

5.3.3.9.2 Alarm Mode

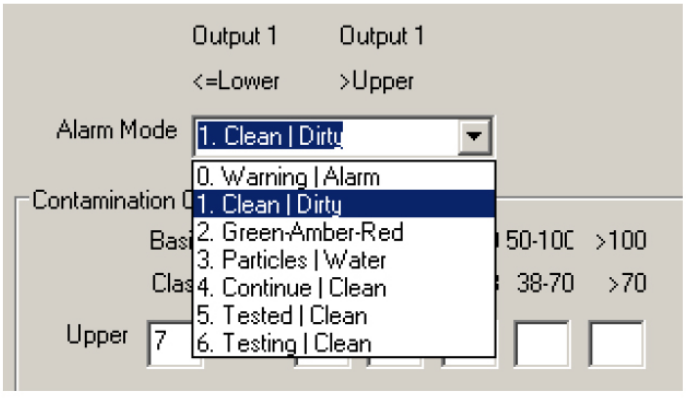


Figure 5.30

The Alarm Mode sets the precise function of the two switched alarm outputs of the HPCM.

This allows the HPCM to be used in a variety of situations. Note that the conditions under which the outputs are turned on are also displayed above the Alarm Mode selector, for each setting.

NOTE: These outputs are distinct from the front panel LED, and that the set alarm mode does not affect the LED. The set alarm mode determines the function of the two switched outputs only. This setting and this entire section can be ignored if these outputs are unused, i.e. the user has not connected them to anything.

New modes are occasionally added after a customer request, this means that modes may not all be implemented unless using the latest firmware revision.

Alarm Mode 0: Warning-Alarm

	Output 1	Output 2
Turns on when	>Lower	>Upper
Intended Function	Warning	Alarm

This allows the HPCM to switch external warning lights or alarms. Output 1 is the “Warning” output, switching on if any of the Lower limits are exceeded. Output 2 is the “Alarm” output, behaving similarly for the upper limit.

Alarm Mode 1: Clean-Dirty

	Output 1	Output 2
Turns on when	≤Lower	Upper
Intended Function	Clean	Dirty

This could be used in a cleaning system that attempts to maintain a cleanliness level by switching a pump on and off.

Output 1 is the “Clean” output, coming on when the result is less than or equal to the lower (“Clean”) limit. This could be used to stop a cleaning pump.

Output 2 is the “Dirty” output, coming on when the result is greater than the upper (“Dirty”) limit. This could be used to start the cleaning pump.

Alarm Mode 2: Green-Amber-Red

	Output 1	Output 2
Turns on when	<Upper	>Lower
Intended Function	Green	Red

This mode encodes the result in such a way that the internal alarm relays can be used to drive an external remote 3-colour LED indicator. This is a special type of LED containing both red and green emitters, which could be mounted in a control panel. This external LED will then turn green / amber / red according to the test result – in a similar way to the built-in one. Output 1 (“Green”) is turned on when the result is less that the upper limit. Output 2 (“Red”) is turned on when the result is greater than the lower limit. If the result is in between, both outputs are turned on and the LED colour will be amber (i.e. a mixture of red and green light).

Alarm Mode 3: Particles-Water

	Output 1	Output 2
Turns on when	Cleanliness>Upper	Water>Upper
Turns off when	Cleanliness ≤lower	Water ≤lower
Intended Function	Cleanliness Alarm	Water Alarm

This is used when separate alarm outputs are needed for particles (cleanliness) and water content.

This mode is able to use both upper and lower limits such that the outputs have ``hysteresis". If only the upper or lower limit is required, then both upper and lower limits should be set to the same value.

Alarm Mode 4: Continue-Clean

	Output 1	Output 2
Turns on When	>Lower	≤Lower
Intended Function	Continue Testing	Stop Testing / Clean

This is used for a "cleaning" application where a signal is needed to stop testing (for example to stop a pump or signal an external controller).

Alarm Mode 5: Tested Not-Clean

	Output 1	Output 2
Turns on When	Test Complete	>Lower
Intended Function	Test Complete Signal	"Not Clean" Signal

This is used when controlling tests from a PLC using switched outputs. The PLC gives a start signal, then monitors the "Test Complete" output. If the test has failed it can detect this with the "not clean" signal.

``Continuous testing" should not be selected for this mode.

Alarm Mode 6: Testing Not-Clean

	Output 1	Output 2
Turns on When	Testing	>Lower
Intended Function	Test in progress Signal	"Not Clean" Signal

This is similar to mode 5 above. The difference is that output 1 is active during the test and turns off at test end.

``Continuous testing" should not be selected for this mode.

Alarm Mode 7… Customer Requested Modes

Other alarm modes will be defined as and when customers request them.

5.4 Standard Communication Protocols

5.4.1 Modbus

The HPCM can be controlled via commands on its serial (RS485) interface, using the Modbus RTU protocol. It is possible to control every aspect and setting of the HPCM, as is done by the Webtec LPA-View control software. All results and counts are available in all supported formats. We suggest using LPA-View to initially configure the HPCM and check it is performing correctly, and then the customer-written software only has to read the test results. This could be used to integrate the HPCM measurements with a general machine control, vehicle control or factory monitoring system.

Customers wishing to implement their own Modbus controller software will need to refer to the rest of this section

The simplest arrangement is to configure the HPCM to test continuously, with a set interval between tests.
For example; a Test Duration of 2 minutes and a Test Interval of 10 minutes.
The Start Testing Automatically selection can be used so that the unit does not require a start signal.

Then, the most recent test results can be read from the appropriate Modbus Registers.

Register	Function
56	4µm Result Code
57	6µm Result Code
58	14µm Result Code

5.4.1.1 Set Up

Protocol Type	RTU (not ASCII)
Data Bits	8
Stop Bits	1
Parity	Required, even or none
Baud	Auto-sensing 1200-115200
Signaling	RS485
Mode Address	4 (or user set)

Table 5. Modbus protocol settings

5.4.1.1.1 Communications Check

You should be able to read the product ID code from register 0 (from Modbus node address 204). The product ID code is the value 54237 (decimal) or 0xD3DD (hexadecimal).

5.4.1.1.2 Result Format

The HPCM can present results in several different industry formats (ISO, NAS etc.) The format required can be most easily set using LPA-View; however it is also possible to set it via Modbus. To do this, write the required value 0-4 from table 5A to the TEST FORMAT register 19. The factory set value is 0 (ISO 4406:1999).
The selected format does not affect the particle count values, but does completely change the interpretation of the result codes and set limits, if used.

Note: If the format is changed, then any set alarm limits must be changed too since these will refer to the old format. E.g. a limit of ``NAS 11" cannot be directly expressed using the ISO4406 standard.

Value	Format	Main Class Example	Individual Codes Example
0	ISO 4406:1999		21/20/17
1	NAS 1638	NAS 12	(12 11 11 7 6)
2	AS4059E Table	12A-F	12A/12B/11C/11D/7E/6F
3	AS4059 Table 1	Class 12	12 11 11 7 6
4	ISO 11218 Draft	ISO(12)	12 11 11 7 6

Table 5A TEST FORMAT Register 19

5.4.1.2 Result Codes

The most recent measurements are presented as numeric codes (i.e. numbers) according to the selected TEST FORMAT. These codes can be read from registers 56-63, as per Table 5B.

Register	ISO 4406 Code	AS4059E Table 2 Class	NAS1638/ AS4059E Table 1/ ISO 11218 (Draft) Codes/ Classes
56	≥4µ	Basic	Basic
57	≥6µ		
58	≥14µ	A	5-15
59	≥21µ	B	15-25
60	≥25µ	C	25-50
61	≥38µ	D	50-100
62	≥50µ	E	100+
63	≥70µ	F	

Table 5B RESULT CODES Registers 56-63

5.4.1.2.1 Null Values

For all formats, the special value -32768 (0x8000 hex) is used to represent a ``null" or ``no result" condition. This enables ``No Result" to be distinguished from a 0/0/0 ISO code, for example. ``No Result" could be due to an error condition, or to a measurement not having been commanded yet. This convention is also used for other parameters such as temperature and water content measurements, where applicable.

NOTE: User written programs should take note, to avoid displays like -32768/-32768/-32768 appearing on their front panels.

5.4.1.2.2 ISO4406

ISO 4406 defines a set of code values to represent ranges of counts of particles greater than the nominated sizes of ≥4, ≥6 and ≥14µm(c). The HPCM can display codes from 0 to 24. The three-part code is available in the first 3 RESULT CODES.
We additionally make available equivalent codes for the other sizes from 21 to 70µm(c), as per Table 5B.

5.4.1.2.3 NAS 1638/ AS4059E-1/ ISO11218

These assign code numbers for the particle counts in each size range shown in the table. The ``basic" class is then the highest of these individual codes. The basic class is in the first register, with the individual classes made available in the registers shown.

For these standards there is a complication in that they all define an additional class ``00". This is an extra ``cleaner than class 0" class. We distinguish this from 0 using the numeric value -1. Negative numbers are represented in a Modbus register using the ``twos complement" notation. If the user program interprets this as a positive number it will appear as 65535 (0xFFFF hex).

Classes range from 00(-1) to 12.

5.4.1.2.4 AS4059E-2

AS4059E Table 2 also has some similarities to NAS1638. In terms of the representation in Modbus registers, the main differences are an extra 4-6µm(c) size range and the addition of an extra ``000" class. This is represented using the number -2. If the user program interprets this as a positive number it will appear as 65534 (0xFFFE hex).

5.4.1.2.5 Temperature and Water Content Measurements

These are contained in the TEMPERATURE register 33 and the RH (relative humidity) register 34. These are scaled by a factor of 100, so that values of 12.34°C and 56.78% RH would be represented by values of 1234 and 5678 respectively. The temperature can go negative, in which case the usual ``twos complement" representation is used. Most controllers should have a facility for reading ``signed integers" encoded in this way (these will appear as large positive numbers if interpreted instead as negative numbers, for example 65535).

The special value -32768 (0x8000 hex) is again used to indicate ``No result", as per the contamination result codes. This could be due to a sensor failure or to the unit still in the process of powering up.

5.4.1.3 Performing Tests

5.4.1.3.1 Commanding Test Start

If the HPCM is monitoring a single machine, it will normally be configured to test continuously and automatically, so that the contamination measurement can be read out at any time as described above. However some applications need a defined test start and test end, for example end-of-line production testing, where each result relates to a separate item being tested.

These applications can simply use a push button (or relay) wired to the HPCM start signal, or the front panel push button, or can be commanded programmatically via Modbus.

To start or restart a test, write the value 1 to the command register 21. The test duration can be set using LPA-View before installation, or alternatively write the required test time (in seconds) to the TEST DURATION register 18.

5.4.1.3.2 Test Status

A test status code is available in register 30. This contains a number indicating the current state of the HPCM. This allows a system to remotely monitor the HPCM operation, if desired, allowing more specific diagnostics.
NOTE: the fault conditions are also indicated on the front panel LED, while ``No Result" in the case of a fault is indicated using special result values as previously described.

5.4.1.3.3 Test Completion

The TEST COMPLETION is indicated by register 36. This contains a number between 0 and 1000 indicating the test progress (this is also used by LPA-View to drive the test progress bar).

5.4.1.4 Particle Counts

Some quantities are (or may become) too large to fit into a single 16-bit register. For example the 4µm particle count could easily be more than 65535. These items are represented using two consecutive registers; the combination makes up a 32-bit integer. For example, the value of such a 32 bit unsigned integer stored in the two registers 40 and 41 may be calculated using the formula:

Value = (65536 × (register 40)) + (register 41)

The particle counts are stored in registers 40-55, as shown in Table 5D. There are 8 register pairs; each pair encodes one count channel as a 32 bit integer, using two consecutive Modbus registers as explained above. The Counts are per 100ml.

Particle sizes are expressed below according to ISO4406:1999, i.e. equivalent projected area diameter. The sizes have been chosen so that all supported coding standards (NAS, ISO...) can be derived from them. The counts are all cumulative.

Differential counts can be derived by subtraction. E.g., the NAS 5-15µm count could be calculated by subtracting the ISO 6µm(c) count from the 14µm(c) count.

Number	Function	Comment
40-41	≥4µm (c)	
42-43	≥6µm (c)	≥5µm (NAS)
44-45	≥14µm (c)	≥15µm (NAS)
46-47	≥21µm (c)	≥25µm (NAS)
48-49	≥25µm (c)	
50-51	≥38µm (c)	≥50µm (NAS)
52-53	≥50µm (c)	
54-55	≥70µm (c)	≥100µm (NAS)

Table 5D Particle Count Registers

5.4.1.5 Alarms

5.4.1.5.1 Alarm Mode

The HPCM includes two relay outputs that can optionally be used for signaling the state of the unit. These are normally used in ``stand-alone" applications where the Modbus interface is not used (since a Modbus controller / PLC already has all the exact results available in digital form and can work with these directly.)
There are a number of preset ``modes" that determine the exact function of the relays. Refer to the alarm mode section for more details (Section 5.3.3.9.2).

These modes are normally set at installation time using our PC software package LPA-View. But it is also possible to use Modbus to set the operating mode of these relays, by writing the corresponding integer to the alarm mode register 26.

5.4.1.5.2 Alarm Limits

Settable Upper and Lower limits for particulate contamination are provided.
These are two groups of 8 registers representing the ``Upper Limit" and ``Lower Limit" for particulate contamination. These are 64-71 and 72-79 respectively.
These are expressed in terms of the result codes using the same format as in Section 5.4.1.2. An additional special value of 0x8000 (hexadecimal representation) is used to signify a ``don't care" setting for that limit code.

5.4.2 CAN-bus

The HPCM supports the major CAN-bus basic message format standards CAN 2.0A (11 bit identifiers) and CAN2.0B (29 bit identifiers). J1939 and CanOpen are higher level protocols built on these basic standards. CanOpen uses CAN2.0A and J1939 uses CAN2.0B standards. The HPCM does not implement either of these protocols. Instead it defines a few CAN-bus messages to communicate data. However the message identifiers have been chosen so as to allow operation with both J1939 and CanOpen. Generally it should be possible to use the HPCM with either, as well as other CAN-bus systems.

PRODUCT INSTALLATION

1. Installation

- Perform a general installation and check of the HPCM as detailed in section 5 earlier.
- Perform a one-off general configuration check of the HPCM using a PC running LPA-View e.g. set it to test continuously and automatically start testing on power up. This procedure is described earlier in section 5. You will need a suitable RS485 interface, such as the HPCM-USBi.
- Use the software to configure any CAN-bus specific parameters required by your CAN-bus network, for example configure a CAN-bus message ID and baud rate

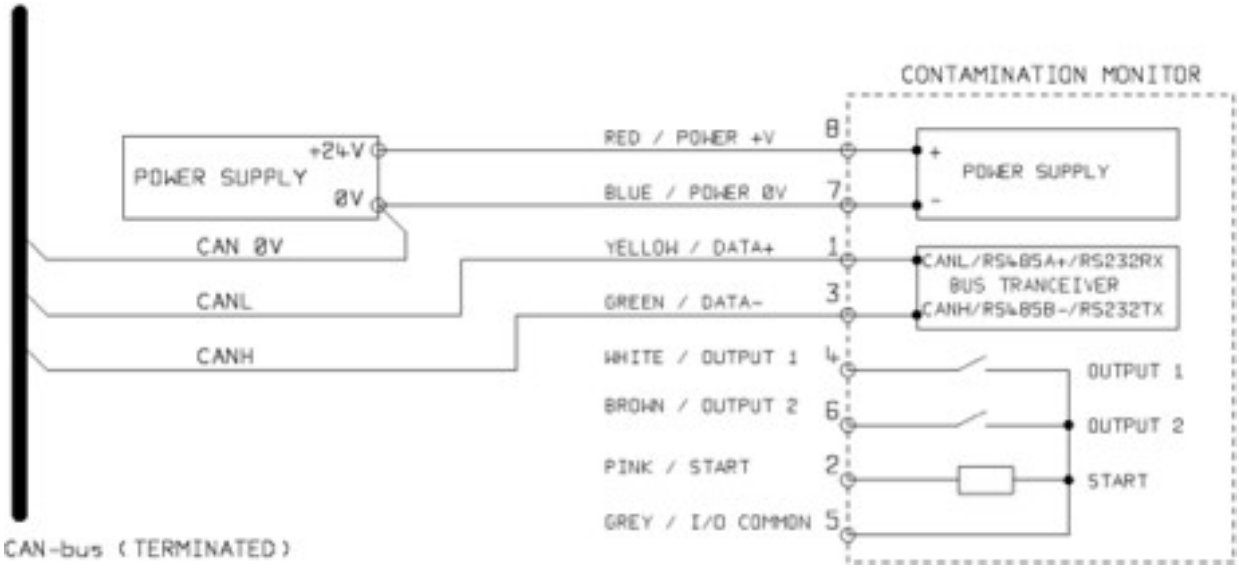


Figure 5.31

- Connect the HPCM to your CAN-bus network and provide a 24VDC power supply, as per figure 5.31.
- The HPCM automatically emits the test result message after each set test interval.
- Configure your CAN-bus controller to listen for the messages configured above.
- The HPCM requires a DC power supply and the two CAN-bus signals CANL and CANH, as shown in Figure 1. The numbers shown are the pin numbers of the circular connector that plugs into the HPCM.
- CAN-bus requires the network to be terminated at each end. This must be done externally to the HPCM.
- The CAN-bus signals CANL and CANH are referred to the system 0V supply. These should stay within the common mode range allowed by the ISO-11898-4 CAN-bus standard relative to the HPCM 0V connection. This range is -2V to +7V. This can be normally be ensured by connecting together the HPCM 0V and the 0V of the CAN-bus controller. The ``CAN 0V" wire shown indicates this link. (Not needed if both CAN-bus controller and HPCM are connected to a vehicle chassis or otherwise ``Earthed".)
- There are other wires available for switched alarm and start signals (optional). These are documented separately in section 5.1.2.

2. Configuration

5.4.2.2.1 Use PC Software for Configuration

The free LPA-View software package is needed in order to initially configure the HPCM. Once configured, the unit can be left connected to the CAN-bus network.

The HPCM was designed to be as flexible as possible. There are large number of options for setting operating modes, test result formats, alarm settings, downloading stored data etc.

The easiest approach is to use LPA-View to configure the test parameters and result format. Then the customer application only has to read the results.

The CAN-bus parameters are configured from the Communication Settings dialogue, accessed from the HPCM Settings dialogue (see section 5.3.3).

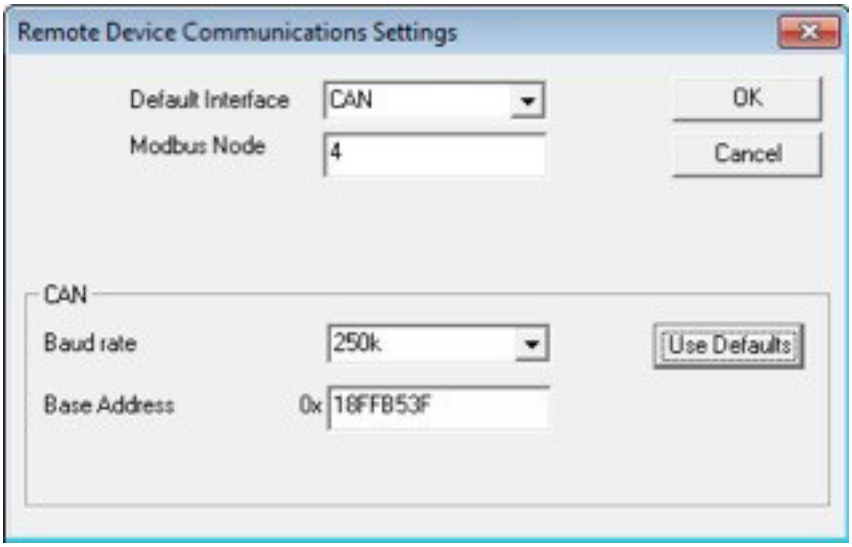


Figure 5.32 Communication Settings Dialogue

The HPCM can use either CAN 2.0A ``basic" format with 11 bit identifiers, or CAN2.0B ``extended frame" format with 29 bit identifiers.

5.4.2.2.2 CAN2.0B and J1939

The default 29 bit format is designed to be compatible with the J1939 standard. It should also be possible to use the HPCM with any system that permits arbitrary raw CAN-bus 2.0B identifiers to be received.

The dialogue shows the default CAN-bus settings. The HPCM transmits all data using a range of message identifiers starting at that selected. If the ``Use Defaults" button is pressed, the program constructs an identifier suitable for J1939 (i.e. this will use PGNs within the region allocated to proprietary applications, starting at 0x00FFB53F).

At the end of each test, the HPCM will generate a ``test result codes" message using the selected CAN-bus identifier.
On a J1939 network the test result will appear as PGN 0x00ff00. Users not using J1939 can simply listen for messages with the identifier shown in the dialogue, e.g. 0x18FFB53F.

5.4.2.2.3 CAN2.0A and CanOpen

The 11 bit format is designed to be compatible with the CanOpen standard. It can also be used with any system that allows raw CAN-bus 2.0A identifiers to be received.
In order to use 11 bit identifiers (CAN 2.0A) set a value below 0x7ff for the ``Base Address".
For a CanOpen network, use a base address of 0x182 for example. This will result in message IDs corresponding to the CanOpen ``pre-defined connection set".

1. Operations

5.4.2.3.1 CAN-bus Settings

CAN-bus physical layer	ISO-11898-2
Protocol type	CAN2.0B (29 bit identifiers) CAN2.0A (11 bit identifiers)
Baud	User Set 1M/800k/500k/250k/125k/100k/50k/20k/10k
Identifier Range	User Set

5.4.2.3.2 Operation

Typically the installer will have configured the HPCM to automatically start continuous testing. At the end of each set test interval (e.g. 2 minutes) the HPCM will emit a CAN ``Result Codes" message using the set CAN identifier (e.g. 0x18FFB53F using hexadecimal notation). So a typical CAN message might be:

	Byte							
Identifier	1	2	3	4	5	6	7	8
0x18F-FB53F	12	8	2					

5.4.3 Analogue 4-20mA Modes

The HPCM provides two analog 4-20mA current loop outputs, A and B. In order to provide the possibility of transmitting more than two parameters, several different modes can be chosen to suit the application.

5.4.3.1 Fixed – NAS1638 and RH

The HPCM result format must be set to NAS1638. The outputs then simply indicate the NAS1638 contamination class and the RH level as follows:

Output A	Contamination Code =mA-5	4mA NAS 00 5mA NAS 0 6mA NAS 1 … 17mA NAS 12 20mA OVERRANGE
Output B	RH% =(mA-4)*100/16	4mA 0% RH 5mA 6.25% RH 20mA 100% RH

5.4.3.2 Time Multiplexed Schemes

These output the result parameters on a single output (A) in a timed sequence. This mode would be used to read the result parameters in to a PLC. The PLC would need to be programmed to read each parameter at the correct time.
These modes are still under development; please contact Webtec for details.

- We output a current <5mA (4.0mA) for 1 second to indicate start of “frame”, this is denoted by <SYNC> in the following examples. The PLC needs to continuously check for this condition so that it can start the timer sequence for acquiring the results.
- Parameters are output in a sequence, one parameter per second until the end of the list.
- We use an “out of range” current of >20mA (24mA) to indicate parameter not available.
- The sequence is then repeated

RH Coding

The RH value is encoded according to the formula:
mA = 6 + (RH% / 10)
or
RH% = (mA – 6) * 10

So 0% RH =6mA, 100% RH =16mA (max legal measurement value), unavailable = 24mA

Temperature Coding

The temperature in degrees C is encoded according to the formula:
mA = 10 + (°C / 10)
or
°C = (mA – 10) * 10

NAS1638, AS4059E1, ISO11218
Parameters are output in the sequence:

<SYNC> <CLASS> <CLASS 5-15um> <CLASS 15-25um> <CLASS 25-50> <CLASS 50-100> <CLASS 100+> <RH> <TEMP> <...>

These contamination classes are encoded as:

Class = mA -7

For example: Class 00 = 6mA, Class 0 = 7mA, Class 1 = 8mA, ... Class 12 = 19mA, Off scale = 20mA

ISO4406
Parameters are output in the sequence:

<SYNC> <ISO4> <ISO6> <ISO14> <ISO21> <ISO25> <ISO38> <ISO50> <ISO70> <RH> <TEMP> <...>

ISO4406 codes are encoded as:

mA = 6 + ISO / 2
or
ISO = 2 × (mA – 6)

So 6mA = ISO 0, 20mA = ISO28

AS4059E2
Parameters are output in the sequence:

<SYNC> <BASIC> <A> <B> <C> <D> <E> <F> <RH> <TEMP> <...>

AS4059E2 contamination codes are encoded as:

mA = 6 + (code + 2) / 2)
or
code = 2 × (mA – 6) – 2 = 2 × mA – 14

So that 6mA = -2 = 000, 6.5mA = -1 = 00, 7.0mA = 0, 7.5mA = 1, 13mA = 12 =max valid reading, 20 mA = over range

5.4.3.3 Time Multiplexed Scheme 2

This outputs the parameters as currents, using values designed for viewing directly on a programmable process meter. There is no “sync” value but the final parameter stays on for 2 seconds instead of 1. To avoid confusion the RH channel does not output temperature (just static RH value). The other channel outputs just the overall contamination code value except for ISO4406 where it cycles between 3 ISO codes.

5.5 Disposal

- All HPCM products are sent in a cardboard box with foam inside and these should be recycled accordingly.
- Fluids used with the HPCM should be fully drained and disposed of according to EU waste framework directive and ISO44001

RELATED PRODUCTS

6.1 HPCMUSBI

The HPCM-USBi is a plug and play solution for easily connecting a computer to the HPCM.

It includes a USB:RS485 interface with a terminal block pre-wired with the HPCM cable. An extra terminal block is provided for any customer wiring to external devices.

An external DC adapter supplied can be used to power the complete system, or if the computer is always connected during use, power can be taken directly from the USB cable.
Note: Computer should have mains power applied at all times.

Detailed installation and usage instructions are provided in the separate product user guide.

7 Troubleshooting / FAQ

7.1 Misuse of Product

- The product should be connected to a power supply within the rating of the product and not wired directly to the mains.
- This product should be connected to a hydraulic line; this must not exceed the upper pressure limit of the product
- Connection hoses should never be allowed to lie along the floor when the HPCM is installed and in use.
- The operator should follow all standard operating procedures previously set at the operating location as well as the procedures required by the manufacturer.
- The HPCM is not suitable for use in an explosive environment or an ATEX zone.
- Over-tightening of test points/ hoses can damage threads causing the unit to fail.
- The product is designed with no moving components. Should it be used outside of its fluid viscosity specification the unit will flag a flow error and invalidate that test result.

7.2 Fault Finding

7.2.1 LED Flashing / Fault Codes

The HPCM front panel led indicates a fault by a number of white flashes, with a red background. The number of flashes indicates the fault code, the screen version will also display the fault code and function:

1. Optical - An optical fault could indicate LED failure or blockage of the optical path. Try flushing with Petroleum Ether, or return to Webtec.

2. Low Flow - The HPCM estimates the flow by measuring the transition time of the particles. The Low Flow warning indicates that the flow rate is below the minimum recommended level (A). Note that the alarm should be disabled in the settings when used on clean systems, such as flushing/cleaning rigs, where the particle count could reach 14/12/10 or lower.

3. High Flow - The flow rate is above the maximum recommended level. This will degrade the accuracy of the particle counts.

4. Logging - Fault with data logging memory.

5. Water Sensor - Fault with the water sensor.

(A) The unit will still work but may be more susceptible to errors caused by pressure fluctuations. This warning can also come on when there are no particles whatsoever detected, i.e. the fluid is totally “clean”. In this case the correct result e.g. 0/0/0 is still generated.

7.2.2 Test Status

The status is shown on the HPCM screen. This contains a number indicating the current state of the HPCM, according to the table below. This allows a system to remotely monitor the HPCM operation, if desired, allowing more specific diagnostics (B).

Value	Function	Comment
0	NOT READY	Unit is powering up or there is some problem
1	READY	Unit is powering up or there is some problem
2	TESTING	Test in progress
3	WAITING	Waiting between tests (D)
128	FAULT OPTICAL	LED failure/ sensor blocked/ filled with air
129	FAULT FLOW LOW	Flow too low for reliable test (E)
130	FAULT FLOW HIGH	Flow too high for reliable test
131	FAULT LOGGING	Fault with data logging
132	FAULT WATER SENSOR	Water sensor failure

Table 7A

(B) However the fault conditions are also indicated on the front panel LED, while ``No Result" in the case of a fault is indicated using special result values as previously described.
(C) User has not set tests to occur automatically.
(D) User has set a non-zero test interval.
(E) Or fluid is totally clean (no particle counts). Flow alarm can be turned off by user if this is a problem, for example cleaning rigs.

7.2.3 Other Faults

Unexpected results obtained from sample

- Check that the microbore pressure hose has been fully connected at both the system and HPCM ends. NOTE: removing either hose from the HPCM is not indicative of flow through the HPCM as the hose end is now at atmosphere. The pressure drop across the HPCM should be verified.
- Confirm that the flow through the HPCM is within the range of the unit.
- High water / aeration levels

Remote Device dialogue not responding to buttons being pressed

- Check that correct COM port has been selected in the Remote Device dialogue.
- Check USB driver has been installed.
- Disconnect power supply to HPCM and then reconnect it.

If the HPCM has been subjected to excessive contamination and a blockage is suspected, a flush with a suitable solvent may clear the blockage.

The standard HPCM is fitted with FKM seals, so Petroleum Ether or Iso Propyl Alcohol may be used for this purpose.

DO NOT USE ACETONE

7.3 Test Duration

The set Test Duration is the amount of time for which particle counts are accumulated, before the test result is updated. The default of 120 seconds is likely to be suitable for most applications. However it is possible to set other values.

A shorter time enables the unit to respond more quickly to variations in cleanliness. This may be desired in order to reduce the product test time in a production line situation.

A longer test time enables the unit to average out variations in cleanliness and produce a more stable result. This is especially true for the larger particle sizes. In clean systems there are very few of these, so a large amount of fluid needs to be sampled in order to count a statistically significant number.

Another factor is the flow rate. This can be traded off with cycle time, since a higher flow allows the same amount of fluid to be sampled in a shorter time.

“Very Clean” Systems – Longer test times / higher flows are needed.

“Normal” or “Dirty” Systems – Shorter test times or lower flows are acceptable.

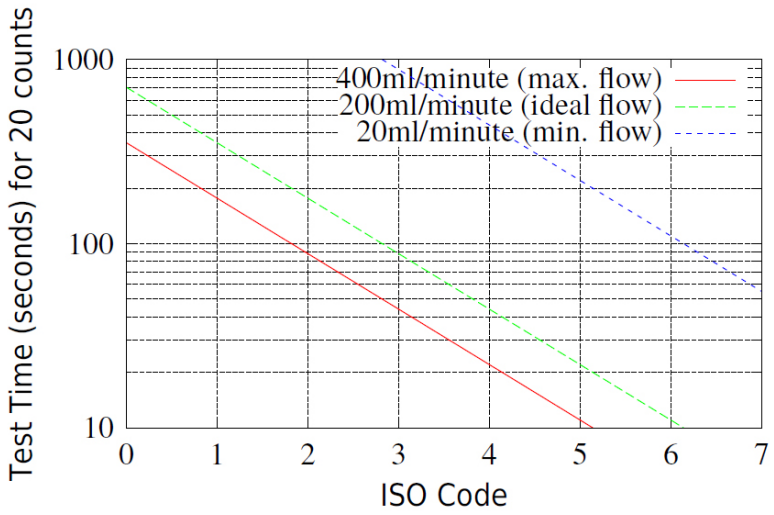


Figure 7.1 Test time needed for reliable indication by ISO code

TROUBLESHOOTING / FAQ

8 Reference

8.1 Further Modbus Information

The HPCM is a Modbus Slave. That is, it responds only to commands sent to it by the Modbus controller (the Modbus Master). The controller can be a program running on a PC, or a PLC.

Modbus requests are sent to the configured HPCM node address. If there is only one HPCM on network segment, then the ``Permanent Address" of 204 can be used. If there is more than one, then unique node addresses must be configured for each. NOTE: This is not part of the Modbus specification (and in fact violates it). The HPCM will always respond on node address 204, in addition to the other set value. This was done so that LPA-View can connect directly without configuration or scanning of the network.

The Master periodically sends a Modbus command ``frame" to the HPCM node address. The HPCM acknowledges each request with a response frame.

8.1.1 Modbus Registers

The Modbus protocol defines many types of information interchange commands (``function codes"). However in order to simplify implementation the HPCM only uses one type - the Modbus ``Register". Conceptually the HPCM appears as a collection of Modbus Registers. Each register is numbered - the HPCM has 125 registers.
Each register holds a number representing some quantity. For example, register number 2 holds a number indicating the HPCM software revision.

8.1.1.1 Register Numbering

Addresses shown here are those appearing ``on the wire". Unfortunately some Modbus controllers may translate these addresses to different ones. For example for some controllers the user will need to use ``addresses" starting at 40000 instead of 0.
The HPCM uses the registers from 0-124 (this allows all registers to fit in a single Modbus frame). Registers can be divided into classes as follows:

Status Registers – these are 'read only' registers that indicate test results and HPCM status. They can be read freely at any time (although test results are only valid after a successful test).

Setting Registers – these are read-write registers used to hold the HPCM settings. Take care not to inadvertently write to any of these registers since the HPCM settings will be altered!

Calibration Registers – Some registers, not documented here, are protected settings that can only be altered during factory calibration.

Number	Function	Units	Representation
0	Product ID		Unsigned integer
1	Protocol ID		Unsigned integer
2	Firmware Version	x100	Unsigned integer
3	Hardware options		Bitmap
4-5	Machine Serial Number		32 bit unsigned integer
6	Modbus Address		Integer
7	Ignore Initial N		Unsigned integer
8-9	Test Number		32 bit integer
10-17	Test Reference		Array of 16 packed characters
18	Test Duration		Unsigned integer
19	Test Format		
20	Test Mode		
21	Command		Unsigned integer
22-23	Test Interval	S	Unsigned 32 bit integer
24-25	Date/Time	Date	Unsigned 32 bit integer
26	Alarm Mode		Unsigned integer
27	Reserved		
28	Faults		
29	Reserved		
30	Status		Unsigned integer
31	Status Flags		
32	LED Level		Unsigned integer
33	Temperature	°C x100	
34	RH	% x100	
35	Peak Pulse		Unsigned integer
36	Test Completion		Unsigned integer

Number	Function	Units	Representation
37	Flow Indication		
38-39	Reserved		
40-55	Particle Counts		
56-63	Result Codes		
64-71	Contamination Limit Upper		
72-79	Contamination Limit Lower		
80	Limit Water Upper	% x100	signed integer
81	Limit Water Lower	% x100	signed integer
82	Limit Temperature Upper	°C x100	signed integer
83	Limit Temperature Lower	°C x100	signed integer
84-85	Log Interval	Seconds	Unsigned 32 bit integer
86-87	Last Download	Date	Unsigned 32 bit integer
88	Language		Unsigned integer
89-116	Reserved		
117-118	Calibration Due	Date	Unsigned 32 bit integer
119-120	Calibration Last	Date	Unsigned 32 bit integer
121	Reserved		
122	Calibration LED Level Last		
123	Calibration LED Level Initial		
124	Reserved		

Table 8A Modbus Register Map

8.1.1.2 Representations

Modbus Registers - All quantities are represented using Modbus registers. Modbus registers are 16 bit (0-65535 decimal or 0-0xFFFF in hexadecimal notation).

Unsigned Integers - These are simply single Modbus registers. Each can take values from 0 to 65535.
They may be simple numeric quantities such as ``test time in seconds". They can also be enumerations such as ``result format" where ``0" means ISO4406, ``1" means NAS1638 etc.

Signed Integers - These are used for quantities that may become negative, such as °C. They are also used for result codes using formats similar to NAS1638, where we have to represent the NAS ``00" class as -1, and ``000" as -2.
Signed integers are represented in single Modbus registers using the ``twos complement" standard, as usual in computing. If a user-written program incorrectly interprets a signed integer as unsigned, then positive numbers will still be interpreted correctly. However, small negative numbers will appear as large positive ones. In particular, -1 appears as 65535 and -2 as 65534. These might be seen when interpreting the NAS codes mentioned above.

Take care when writing software dealing with NAS codes or Temperature measurements.

32 Bit Unsigned Integers - Some quantities are (or may become) too large to fit into a single 16-bit register. For example the Test Number could eventually increment to more than 65535. These items are represented using two consecutive registers; the combination makes up a 32-bit integer. For example, the value of such a 32 bit unsigned integer stored in registers 8-9 may be calculated using the formula:

Value = (65536 × (register 8)) + (register 9)

Bitmaps - Bitmaps are again single 16-bit Modbus registers, but they have a special interpretation. Each ``bit" in the register has a separate function. The most important example is the ``status flags" register (31). Each register bit encodes a separate function, for example ``result valid", ``new result", ``over temperature alarm" etc. In this document bits are numbered starting with bit 0 = least significant bit.
A user programming environment such as a PLC programming system or a high level computer language will normally have functions that allow easy access of individual bit values in a register.

Arrays - An Array is simply a sequence of objects packed in consecutive registers. For example the ``result codes" are in an array of 8 registers. Code [0] is in register 56, code[1] is in register 57 etc.
In the case of an array of 32-bit integers, each element itself takes up 2 registers, so there are twice as many registers used as elements in the array. In the case of the particle counts array, there are 8 particle sizes counted so these are stored in 8 × 2 = 16 registers.

Packed Characters - These are used to encode the user-settable ``test reference" string, used to label each test. Characters are packed two per Modbus register. This will probably not be used in a user-written Modbus program, but in principle the test reference could be set to a different value for each test. The test reference string consists of 16 characters packed into an array of 8 consecutive registers.

Date/Time - A ``Date" represents a calendar date and time as a 32 bit unsigned integer (it is the number of seconds since Jan 1 1970). User programs will not generally have to deal with this, but in principle they could e.g. read or set the real time clock from registers 24-25. It can be useful during development to be able to read the clock and see a continuously incrementing value of seconds.

8.1.1.3 Register Functions

8.1.1.3.1 Test Mode

Factory set value: 0
This is the "test mode", each bit represents an option corresponding to a tick box on the HPCM settings screen (see our LPA-View software and in the HPCM manual).

Each bit of the register encodes one tick box.
The factory set mode is 0 for all bits, so all the tick boxes are turned off. You may want to turn on bit 8 (disable low flow alarm when clean) if you have a very clean system.

Bit	Function	Comment
0	CYCLE_COTINUOUS	Continuous Testing
1	START_TEST_AUTOMATICALLY	Start Testing Automatically
2	CONTINUOUS_STOP_WHEN_CLEAN	Stop Testing When Clean
3	CONTINUOUS_LOG_EVERY_TEST	Continuous Mode: Log Every Test
4	CONTINUOUS_CONFIRM_TARGET	Repeat final test to confirm target level achieved
5	RESERVED	
6	RESERVED	
7	SIMULATE	Produces simulated test results
8	LOW_FLOW_CLEAN_DISABLED	Prevents spurious low flow alarms on clean systems

Table 8B Test Mode Register Bit Definitions

8.1.1.3.2 Command Register

This is register 21. It is special in that writing a number to this register does not store the number, but instead commands the HPCM to perform a function according to the number written. The main command is ``START", but the others are documented here for completeness and avoidance.

Bit	Function	Comment
1	START TEST	Start or Restart a test
2	RECALCULATE	
3	FORCE OUTPUT 1 ON	
4	FORCE OUTPUT 1 OFF	
5	FORCE OUTPUT 2 ON	
6	FORCE OUTPUT 2 OFF	
7	TEST MODE ON	Flashes LED and exercises outputs
8	TEST MODE OFF	
9	STOP	Abort a test in progress
10	LOG ERASE	Caution!
11	LOG SEEK END	
12	LOG SEEK PREVIOUS	

Table 8C Command Register

8.1.1.3.3 Status Register

This is read-only register 30. It contains a number (an enumeration) indicating the status of the HPCM.

8.1.1.4 Bitmap Functions

8.1.1.4.1 Status Flags Bitmap

This is read-only register 31. It represents the states of various items in a bitmap format.

- Bits 0-2 are so that external equipment (for example LPA-View or a PLC/MMI) can display, update and log results intelligently.
- Bits 3 and 4 can be used to monitor the test progress.
- Bits 5-10 are used to generate alarms. Depending on the selected alarm mode, they operate the alarm relay output(s). But they can also be monitored directly by a PLC/MMI program and used to drive indicators, for example.
- Bit 11 is used internally to detect that the HPCM is being controlled by Modbus (from a PLC or by LPA-View).
- Finally bits 12-14 reflect the state of the HPCM ``start signal" input and alarm output relays.

Bit	Function	Comment
0	RESULT_VALID	Current result is valid
1	RESULT_NEW	A new result is available
2	RESULT_LOG	Current result should be logged
3	TESTING	Test in progress
4	COMPLETE	Test is complete
5	ALM_HI_COUNT	High particle count alarm
6	ALM_HI_H20	High water content alarm
7	ALM_HI_TEMP	High temperature alarm
8	ALM_LO_COUNT	Low particle count alarm
9	ALM_LO_H20	Low water content alarm
10	ALM_LO_TEMP	Low temperature alarm
11	REMOTE_CONTROL	Unit is under remote control
12	IO_IP	Start signal input
13	IO_OP1	Alarm output 1
14	IO_OP2	Alarm output 2
15	UNUSED	Not currently used

Table 8D Status Flags

8.1.1.4.2 Fault Flags Bitmap

This is read-only register 28 (firmware 0.43 or higher required). It represents detected device or installation faults in a bitmap format. The faults are also available as result codes in the status register; however those are transient and may only appear briefly before a new test is started.

The fault bits here remain until the end of the next test (where they may be cleared if the fault has gone).

Bit	Function	Comment
0	OPTICAL FAULT	See table 8A
1	LOW FAULT	See table 8A
2	HIGH FAULT	See table 8A
3	DATA LOGGING	See table 8A
4	WATER SENSOR	See table 8A

8.1.2 Implementing Modbus

This section is for advanced users who wish to do their own programming to implement the Modbus controller. It is not needed if the users control system already has direct support for being a Modbus master. The following describes a minimal system capable of periodically reading data from the HPCM; it is not intended as a general purpose Modbus implementation.

For a background to this section the implementer can review the Modbus source documents:

http://www.modbus.org/docs/Modbus_over_serial_line_V1.pdf
http://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b.pdf

In order to collect data from the HPCM, the users control system needs to be able to send a Modbus command frame and receive a response frame via the RS485 signals.
A frame consists of a sequence of bytes, transmitted back-to-back over the RS485 interface.

A command frame can be generated corresponding to a Modbus ``read registers" command. Using hexadecimal notation, the sequence required to return all registers would be a sequence of 8 bytes:
<0xCC> <0x04> <0x00> <0x00> <0x00> <0x7D> <0x20> <0x36>

This sequence is decoded by the HPCM as:

<0xCC> = <slave address>
<0x04> = <function code:read registers>
<0x00> <0x00> = <start register high> <start register low> (2 bytes)
<0x00> <0x7D> = <number of registers high> <number of registers low> (2 bytes)
<0x20> <0x36> = <checksum high> <checksum low> (2 bytes)

The HPCM will then return a 255 byte long response frame containing the requested register contents.

This 255 byte response frame looks like:
<0xCC> <0x04> <0xfa> <250 bytes of data> <2 bytes of checksum>

The <250 bytes of data> contains the contents of the 125 registers requested. Each 16 bit register is encoded in two sequential bytes, in high-low (``big-endian") order.
The simplest method is then to read the required registers directly out of the data area of this response frame. For example, the HPCM product ID code appears in Modbus register 0. This would therefore appear in the first two bytes of the data area above, or at the 4th and 5th bytes counting from the start of the frame. In a programming language like ``C" the product ID could be extracted from an array containing the frame using a statement like:

unsigned product_id = 256*buf[3+0] + buf[3+1];

Users of PLCs or other programming languages will hopefully be able to translate using the information provided here.
The HPCM product ID is 0xD3DD (hexadecimal) or 54237 (decimal). This fact can be used as a check when attempting the above implementation.
Finally we come to extracting the test result. Referring to the HPCM Modbus register map, the test result codes appear in registers 56-63. In the case of NAS1638, the overall NAS code is in register 56. So a program can extract the overall NAS code from the result frame using logic equivalent to the ``C" language expression:

unsigned NAS = 256*buf[3 + 56*2 + 0] + buf[3 + 56*2 + 1]

This is a statement in the ``C" programming language that reads the 116th and 117th bytes of the response frame, and forms a 16 bit number from these two 8 bit bytes. This reads modbus register 56, the NAS code.

Similar expressions can be used to read the other registers according to the data required.

For PLC users the details will be dependent on their own programming environment and facilities. But hopefully the above can be used as a guide for their own implementation.

8.2 Further CAN-bus Information

8.2.1 Example Walkthrough

Real applications will generally have an existing CAN network, but in this chapter we show how the HPCM can be connected to a PC using a USB:CAN adaptor.

The adaptor used in this example is the ``PCAN-USB", available from Peak System Technik GmbH or a distributor.

We also need to make up a special cable to connect this to the HPCM.

Figure 8.1 PCAN-USB CAN-bus to USB Adaptor

8.2.1.1 Equipment Required

- HPCM with CAN-bus capability
- PCAN-USB USB:CAN Adaptor
- HPCM-USBi interface for initial HPCM setup
- PC with USB ports running Windows
- Special made-up CAN-bus cable detailed below
- 12 or 24 Volt DC power supply

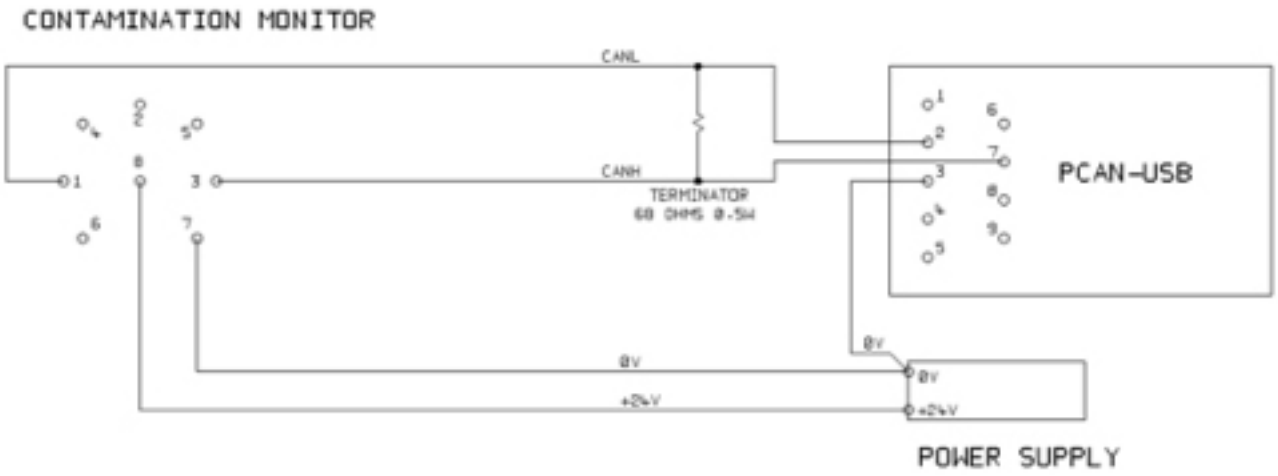


Figure 8.2 Connecting the HPCM to the PCAN-USB Adaptor

The ``TERMINATOR" resistor shown simulates the combined effect of the bus termination resistors normally used on either end of a CAN-bus network. It's value is not critical, anything from 50-150 ohms will work.

8.2.1.2 Initial Configuration

Initially we connect using the HPCM-USBi interface so that the HPCM can be comfortably configured using LPA-View. Detailed information is provided earlier in the user guides but the general procedure is:

- Install LPA-View
- Plug in the HPCM-USBi
- The ``Hardware Found" wizard will appear. If you have an Internet connection you can let Windows Update install the driver, otherwise point the wizard to the drivers provided.
- Plug the HPCM into the HPCM-USBi
- Start LPA-View
- Select Tools/Remote Control to connect to the HPCM.

8.2.1.2.1 Suggested General Settings

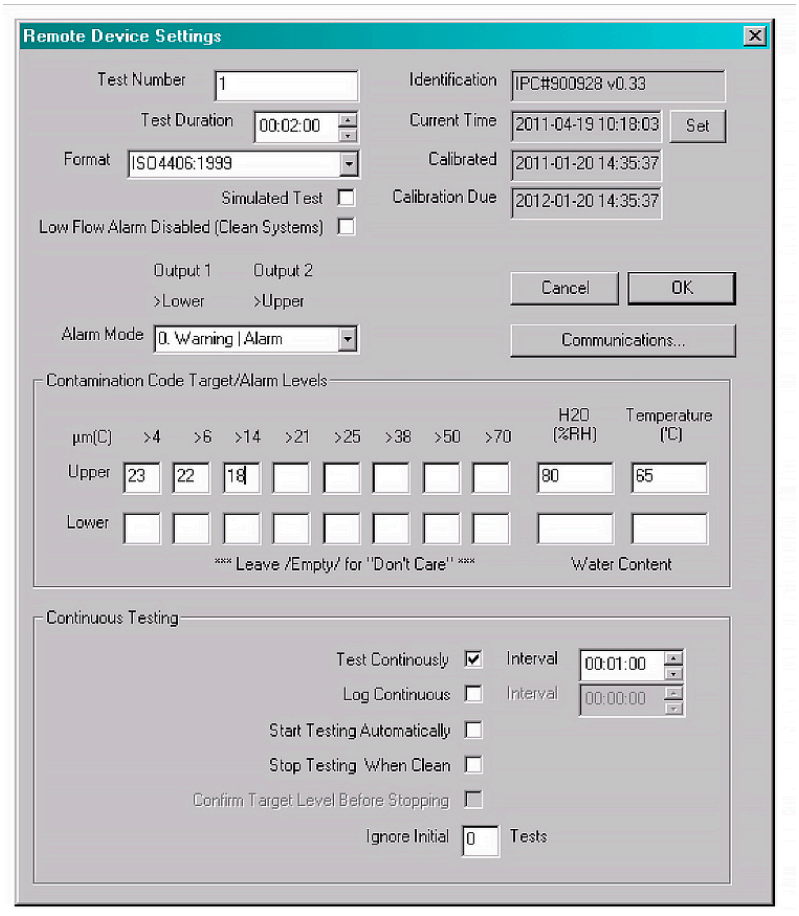


Figure 8.3 General Settings

Press the Settings button to open the Settings dialogue. The important settings for this walk-through are:

- Test Duration; 10 seconds
- Test Continuously: On, interval 0.
- Start Testing Automatically: On
- Stop Testing When Clean: Off
- Simulate Test: On

NOTE: Simulate Test will cause fictitious test results to be generated in order to test communications and demonstrate the unit. Do not forget to turn this off before deploying in a real application!

8.2.1.2.2 Suggested Communication Settings

Press the ``Communications...” button to open the Communications dialogue. See figure 5.24

Select the Interface, Node Number and Baud Rate as shown, then press ``Use Defaults” to assign the ``base address”. This will define the start of the block of CAN message identifiers used by the software (using a value compatible with the J1939 standard).

Press the OK button on the ``Communications Settings” and ``Remote Device Settings” dialogues. Leave the Remote Control dialogue open.

Now check that the HPCM is now set to automatically perform tests:
- Unplug the HPCM circular connector
- Plug it back in
- You should see the connection re-established on the Remote Control dialogue within a few seconds.
- A test should have been automatically started
- The tests should repeat every 10 seconds
- You should see a test result that starts high and decreases with each further test.

Close the Remote Control dialogue and quit the program. Unplug the HPCM at the circular connector.

8.2.1.3 PCAN-USB Software

The PCAN-USB adaptor comes with a software CD. This includes a simple CAN-bus diagnostic utility called ``PCAN-View USB”. This should be installed from the CD.
Connect the HPCM to the computer using the special made-up cable and the PCAN-USB. Power-up the HPCM by turning on the power supply.
Upon connecting the PCAN-USB and starting PCAN-View, the Connect dialogue is presented.

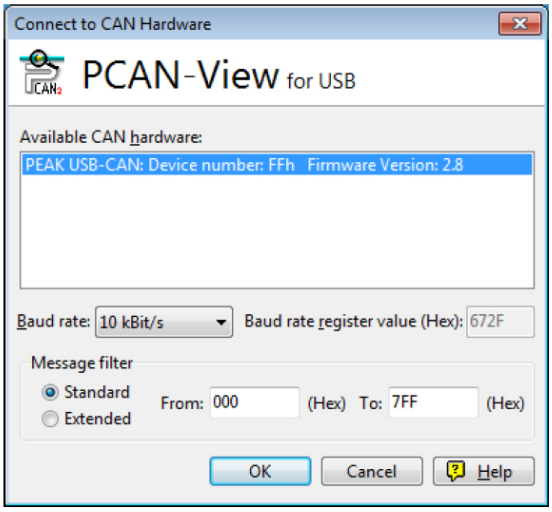


Figure 8.4 PCAN-View Connect Dialogue

Select a baud rate to match that being used on the HPCM, for example 250k. Select the ``Extended" message filter (so that 29 bit identifiers are used). Press OK to go to the main PCAN-View screen.

8.2.1.3.1 Simulated Tests

Plug the HPCM into its circular connector. It should power up and start performing a test.
If everything is working, after about 20 seconds you should see CAN messages similar to that shown below.
This shows the 2nd result received. The first 3 bytes 0x17, 0x15, 0x13 show the 3 ISO codes (the display is in hexadecimal (base16) so the actual code is 23/21/19).

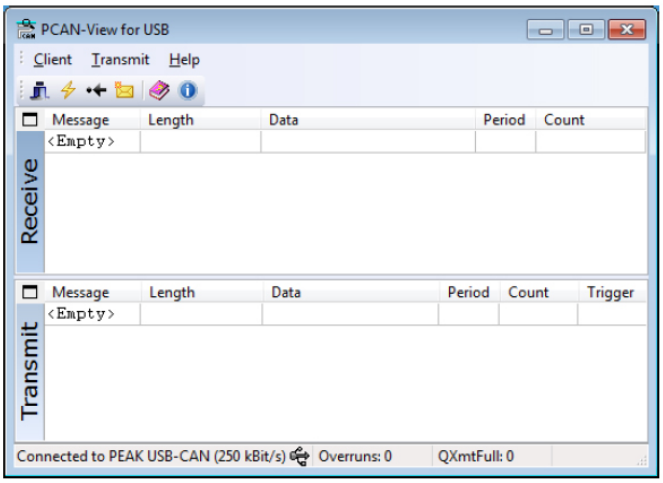


Figure 8.5 PCAN-View Main Screen

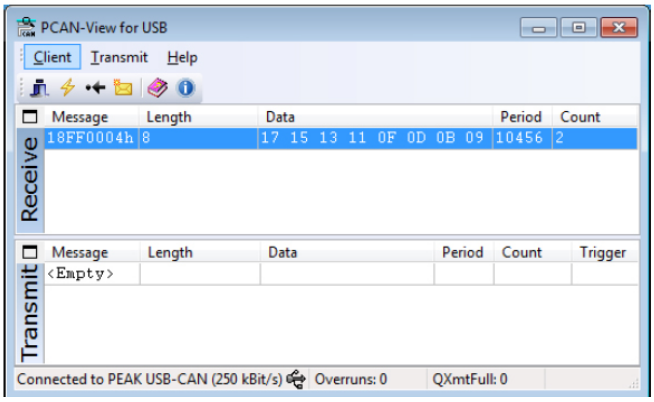


Figure 8.6 Reception of a Test Result Codes Message

8.2.2 Messages

8.2.2.1 CAN2.0B and J1939

The HPCM CAN-bus implementation is designed to be interoperable with J1939 networks. This is done by restricting CAN-bus message IDs to those within the proprietary ranges allocated by J1939. Advanced J1939 features have been avoided, so that customers not using J1939 will also be able to communicate using ``generic" CAN-bus frames. For non-J1939 users the only requirement is that their network should support CAN2.0 (29 bit identifiers).

Broadcast messages use the J1939 PDU2 format. These are transmitted periodically to communicate the HPCM status and the latest test results.

Peer-to-peer messages use the J1939 PDU1 format. These are used to control the HPCM. These are generally optional; customers may opt to leave the HPCM automatically testing and broadcasting results.

Node Address (PDU1)	0x3F (J1939 “Oil Sensor”)
Command & Configuration Message PGN	0xEF3F
Broadcast Messages PGNs	0xFFB5 – 0xFFB9
Default Broadcast Interval	1s
Data Page	0
Priority	6
PDU Format/ PDU specific	Derived from PGN
Byte Endianness	All data is on little-endian byte order

Table 8F CAN-bus Parameters for J1939 Interoperation

8.2.2.2 Non-J1939 CAN2.0B Users

- Taken together these imply a generic CAN “base address” of 0x18FFB53F.
- Command and control messages can then be sent to CAN address 0x18EF3F00.

8.2.2.3 CAN2.0A and CanOpen

On CanOpen networks the results need to be transmitted as ``process data objects” (PDOs) from the ``predefined connection set”. In order to do this, ensure that the set base address is equal to (0x180 + node number). For example, 0x182 to make the HPCM node address 2.

8.2.2.4 CAN-bus Message List

The message ID numbers shown are examples only and are dependent on the set base address.
For CAN2.0A/CanOpen we have an example base address of 0x182. So you see ``2” as the last digit of the entire message IDs. CanOpen interprets this as the device node number. For CAN2.0B/J1939 we have an example base address of 0x18FFB53F. The equivalent node number is ``3F” so you see this appear in all the message IDs. For other node numbers change the set base address value as required. CanOpen has node numbers from 0x01 to 0x7f. J1939 has node numbers from 0x01 to 0xff.

Parameter Name	CAN2.0A ID	CanOpen PDO	CAN2.0B ID	J1939 PGN
Result Codes	0x182	Transmit PDO 1	0x18FFB53F	0xFFB5
Status	0x282	Transmit PDO 2	0x18FFB63F	0xFFB6
Water Sensor	0x382	Transmit PDO 3	0x18FFB73F	0xFFB7
Commands	0x202	Receive PDO 1	0x18EF3F00	PDU1

Table 8G CAN-bus Messages

8.2.2.4.1 Message: Result Codes

This message is transmitted after each test.
The test result is expressed as a set of codes in the selected Test Format (ISO4406, NAS1638 etc.). The test result message is always 8 bytes long, with the result codes packed as follows:

Format:Byte	ISO 4406 Code	AS4059E Table 2 Class	NAS1638/ AS4059E Table 1/ ISO 11218 (Draft) Codes/ Classes
1	≥4µ	Basic	Basic
2	≥6µ		
3	≥14µ	A	5-15 µm
4	≥21µ	B	15-25 µm
5	≥25µ	C	25-50 µm
6	≥38µ	D	50-100 µm
7	≥50µ	E	>100 µm
8	≥70µ	F	

NOTE: The ‘basic’ class is the highest of the individual size classes.
ISO4406 only defines codes for the first 3 sizes 4, 6 and 14µm. we extend the concept to cover the other sizes. This allows limits to be set on the number of large particles, even when using the ISO 4406 coding system.

8.2.2.4.1.1 Special Values

The result codes use a few ``special” values in order to represent codes that are not simple numbers.
The NAS1638 standard defines classes ``00” and ``000”, these are classes ``cleaner” than class 0. We represent these using signed integers of value -1 and -2 respectively (these will appear as 255 and 254 if read as unsigned integers).

8.2.2.4.2 Message: Status

The message is transmitted every 1 second so that it can be used as a ``heartbeat”.
However if no test has been performed yet, the HPCM will wait until it sees other CAN-bus activity before sending anything.

Byte	Bit	Length	Type	Item
1-4	1	32	Unsigned	Test Number
5	1	8	Unsigned	Status Code
6	1	8	Unsigned	Completion
7-8	1	16	Bitmask	Status Flags

Test Number - The current Test Number is an auto-incremented integer or can also be set as part of the Test Start command. This is used to distinguish tests / circuits.

Status Code - This is a number used to indicate the current state of the HPCM, or a fault code in the case of a problem being detected. The codes are listed in Table III. This allows a system to remotely monitor the HPCM operation, if desired, allowing more specific diagnostics.

Completion - A number between 0 and 100 indicating the progress of the test. This will increase from 0 to 100 during the set test time. It can be used to drive a progress indicator.

Status Flags - This is a group of flags indicating test status.

8.2.2.4.2.1 Status Flags Bitmask

This is identical to table 8D

Bits 0-2 are so that external equipment (for example LPA-View or a PLC/MMI) can display, update and log results intelligently
Bits 3 and 4 can be used to monitor the test progress.

Bits 5-10 are used to generate alarms. Depending on the selected alarm mode, they operate the alarm relay output(s). But they can also be monitored directly by a PLC/MMI program and used to drive indicators, for example.

Bit 11 is used internally to detect that the HPCM is being controlled by Modbus (from a PLC or by LPA-View).
Finally bits 12-14 reflect the state of the HPCM ``start signal" input and alarm output relays.

8.2.2.4.3 Message: Water Sensor

Byte	Bit	Length	Type	Item
1	1	8	Unsigned	RH%
2	1	8	Signed	Temperature degrees C

8.2.2.4.4 Message: Commands

Various commands can be sent to the HPCM via CAN-bus.
For J1939 networks Peer-to-Peer (PDU1) Messages are used.
For CanOpen networks Receive Process Data Objects are used.

Byte	Bit	Length	Type	Item
1	1	8	Unsigned	Command Byte (0x00)
2	1	8	enum	(0, 1, 2, …)
3-6	1	32	Unsigned	Parameter

enum	Function	Parameter
1	Start Test	None
9	Stop Test	
13	Start Test	Fixed Test Number
14	Format ISO4406	Set ISO4406 result format
15	Format NAS1638	Set NAS1638 result format
16	Format AS4059_E2	Set AS4059E Table 2 result format
17	Format AS4059_E1	Set AS4059E Table 1 result format
18	Format ISO11218	Set ISO11218 result format

8.3 Hydraulic System Target Cleanliness Levels

Where a hydraulic system user has been able to check cleanliness levels over a considerable period, the acceptability, or otherwise, of those levels can be verified.

Thus if no failures have occurred, the average level measured may well be one which could be made a bench mark. However, such a level may have to be modified if the conditions change, or if specific contaminant-sensitive components are added to the system. The demand for greater reliability may also necessitate an improved cleanliness level.

The level of acceptability depends on three features:
- The contamination sensitivity of the components
- The operational conditions of the system
- The required reliability and life expectancy

Contamination Codes ISO4409:1999			Corresponding Codes NAS1638	Recommended Filtration Degree	Typical Applications
4µm(c)	6µm(c)	14µm(c)		8x200	
14	12	9	3	3	High precision and laboratory servo-systems
17	15	11	6	3-6	Robotic and servo-systems
18	16	13	7	10-12	Very sensitive high-reliability systems
20	18	14	9	12-15	Senstive reliable systems
21	19	16	10	15-25	General equipment of limited reliability
23	21	18	12	25-40	Low pressure equipment not in continuous service

8.4 Clean Working Practices

The majority of hydraulic systems require cleanliness which controls below around a 40 micron threshold (beyond the limit of human eyesight). When analysing particles down to levels of 4um, 6um & 14um you are talking about objects of a cellular/bacterial size. This creates various challenges, and is starting to drive better and cleaner working practices in industry. Our products are at the forefront of this challenge, and will help you to manage the quality and productivity of your systems.

Don't

- Don't eat, drink or smoke around critical systems/processes.
- Don't leave tools, objects, clothing or other materials etc. on surfaces or tanks of critical systems.
- Don't use open tanks on critical systems.
- Don't take samples or perform on-line analysis from the top of a reservoir/tank.
- Don't design/use tanks which contain crevices (internal corners etc.).
- Don't assume that if a sample looks clean, that it is. You won't be able to see the contaminants.
- Don't perform off-line analysis in an "un-controlled" environment. E.g. workshop
- Don't rely on a single test for a capable representation of your system.
- Don't start using your system/process until it has gone through a commissioning period whereby contamination levels are relatively stable.
- Don't mix fluids into the same system. They can emulsify and eliminate any chance of a reliable particle count.
- Don't use unsuitable containers to take a fluid sample.

SERVICE / RECALIBRATION

9 Service and Recalibration

Warranty for	The HPCM is guaranteed for 12 months from date of receipt. See section 3 further details.
Recalibration	The HPCM is recommended to be recalibrated every 12 months. Return to Webtec for recalibration.

FAULT DIAGNOSIS AND REPORTING

10.1 Diagnosing suspect HPCM readings

To enable us to offer a fast, responsive service, it will be helpful if you can supply the following information:

Product Part number HPCM:
Product Serial number:

Application	Powerpack, Filter Trolley, System Application, Other
Industry	Aerospace, Mobile, Industrial, Marine, Oil and Gas, Automotive, Other
Installation	Permanently Installed, Mobile, Other
Fluid type	Mineral, Synthetic, Bio-degradable ,Subsea Fluid, Water, Diesel, Other. Please name and supply material data information for compatibility with internal seals and wetted internal parts
Viscosity	0-1000 cSt
System Pressure	Bar/PSI - Min/Max. Variable pressure / Static pressure
How is HPCM installed?	Pressure line back to reservoir, Pressure line back to system, Return line back to reservoir, Other
Known differential pressure between HPCM inlet and HPCM outlet	
Connection type	Minimess M16 X 2 , Microbore hose, ¼ inch fittings . ¼ inch hose, Other
Length of Fitted Hoses	Inlet / Outlet
Pressure inlet to HPCM	Bar/PSI
Pressure outlet from HPCM	Bar /PSI
Any check valves / Flow control valves / Needle valves fitted	
Check Valve values	Bar /Pressure
Indicated flow through HPCM	
Volume of oil in application	Litres /Gallons
Pump flow	Lpm /Gallons per minute
Type of filtration installed	Pressure, Return, Offline, Other. If offline what is the pump flow rate of filter unit – 5 lpm, 10 lpm, 20 lpm, Other
Filtration micron rating	3 micron, 6 micron, 10 micron, Other
Flow through filter during system operation	Lpm /Gallons per min

FAULT DIAGNOSIS AND REPORTING

System operation per day	8 hours, 16 hours, 24 hours, Other
Intended cleanliness range	
Actual cleanliness range	
Ambient temperature range	
System Temperature range	
Moisture content if applicable	0-100 %
Reason for suspecting errors /fault	Why do you think the HPCM is not reading correctly
Has a Laboratory analysis been carried out?	If yes please supply results and report
Pictures of HPCM screens	Screen 1 - ISO /NAS Screen; Screen 2 -Last 10 readings; Screen 3 - Particle count distribution
Download and send all particle counts from LPA–view	
Pictures of application	
Any Faults showing on HPCM screen	e.g Optical fault, High Flow, Low flow, No readings (-/-/-)
Optical fault What is LED value	What is LED value
Notes and Comments	

Please do not return goods without written authorisation
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For Sales & Service contact
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