目　录

1. 概　述

§1.1 引言

欢迎您选择使用性能更优异、功能更多、采用了专利技术制造的TDS-100系列超声波流量计。

第八版中英文显示TDS-100H型手持式超声波流量计是在同系列、目前仍是主线产品的第七版超声波流量计的基础上开。 其最大的改进是采用了电池供电和发射电路的提高，继而我们将开发更先进的、更可靠的新一代的超声波流量计，后续的版本的流量计也将采用这些先进的电路。

TDS-100型系列超声波量计大量的选用了世界著名的半导体生产厂商诸如：*Philips, Maxim, Ti, Winbond, and Xilinx.* 硬件设计简单、软件功能强大和界面的友好。它采用了低电压多脉冲平衡发射接受的专利技术，使其更能适应工业环境中的变频干扰，达到稳定、正确的工作。

优化的智能信号自适应处理，用户无需任何电路调整。

另外其显著的特征是有内置可充电的Ni-H电池，充满电可连续工作12小时。

先进的电路设计、最新器件的选用、优秀的硬件设计加上中文用户界面友好的软件设计，使新版的TDS-100系列超声波流量计成为国内目前最先进、销量最大的第一名牌产品，很快将进入国际市场赢得认可。

§1.2 特点

* 0.5%线性度
* 0.2%重复性
* 中英文双语窗口化操作
* 4路流量累积器
* 低电压多脉冲平衡超声波发射和接受专利
* 内置数据累积器
* 内置数据记录仪
* 0. 5秒的累积周期
* 良好的抗干扰性
* 100 皮秒的时差测量分辨率

§1.3 工作原理

TDS-100H型手持式超声波流量计是用来测量封闭管路液体流量，它的传感器是采用非接触、附着式的，这样就使安装简单易于操作。

TDS-100H型手持式超声波流量计的两个传感器具有收、发两用的特点。使用者将两个传感器按照一定距离附着在管道外侧即可，可以使用两次声程的V法，四次声程的W法，或者采用声波直接穿过被测管路的相对安装的Z法。 使用者可基于被测管路和流体的特点来选择采用何种方法。 流量计控制两个传感器轮流接收和发射超声波并测量器其间的传播时间，计算时间差值，得到的时差与流体的流速由直接的关系，如下表述：

$$V = \frac{MD}{\sin 2\theta} \times \frac{\Delta T}{T_{up} \bullet T_{down}}$$

其中

θ 是声束与液体流动方向的夹角

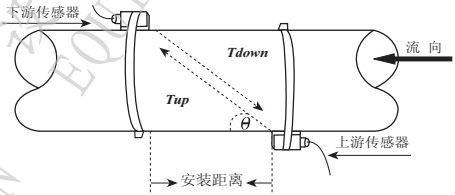
M 是声束在液体中的直线传播次数

D 是管道内径

Tup是声束在正方向上的传播时间

Tdown 是声束在逆方向上的传播时间

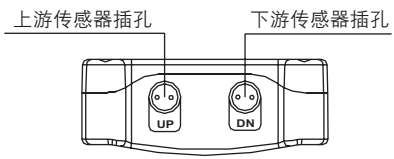
ΔT=Tup-Tdown



§1.4 各部分名称:

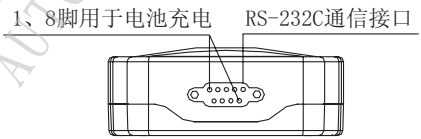
主机：

上部视图



正面视图

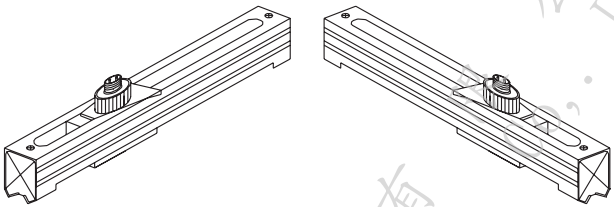
底部视图



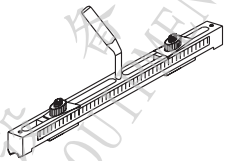
tel: 86-756-8532516　8532518　8532519
website: http://www.ableda.com　http://www.able-tds100.com

传感器：

标准中支架探头 (50mm-700mm)

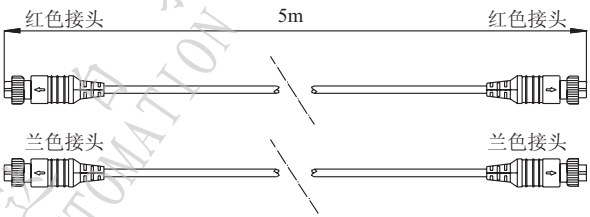


标准小支架探头(20mm-100mm)
（选配件）

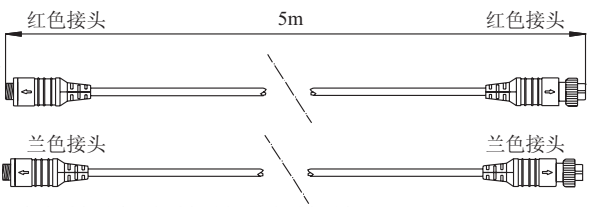


传感器：

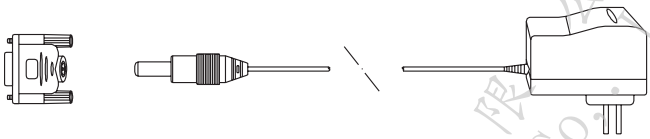
电缆线 5m x2



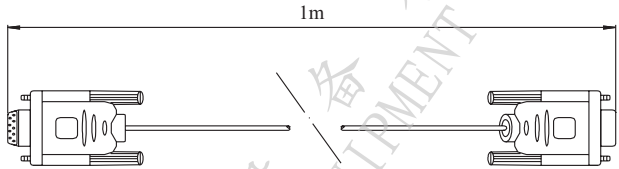
加长电缆线 5m x2
（选配件）



充电转换插头和充电器



RS-232C 通信电缆



§1.5 典型用途

TDS-100型超声波流量计已成功的应用于各行业的计量工作。测量范围20-6000mm（0.5-20英寸），各种流体：水、纯水、污水、海水、化工流体、河水、燃料油等等。原因是这种仪表采用了非接触的测量方式，没有活动机械部件，不受系统的压力和恶劣环境的影响。标准传感器的上限温度是110℃，超过此温度请与厂家或供应商联系。

§1.6 数据的完整性和内置时钟

所有使用者输入的数据都被保存在内置的无压闪速存储器中，即使在机器掉电和电源关闭的状态下，设置密码可以防止参数被偷改和累积器的复位。

内置的时钟是对流量累积数据计算所必备的。只要电池的电压大于1.5V它就可以一直工作下去，如果电池损坏时钟将不再工作并且丢失正确的时间值，使用者必须再电池修复后重新输入正确的时间值。输入了错误的时间值不但会影响到数据累积器，而且还有其他功能。

§1.7 产品的识别

每一款的TDS-100型系列超声波流量计都配备了产品识别，其软件中都具有唯一的、不可更改的ESN电子序列号。使用者若需厂家进行产品维护、维修时务必提供位于流量计的61号窗口中的数据。

§1.8 参数、规格

线 性 度	0.5%
重 复 性	0.2%
准 确 度	示值的±1%，**流速** >0.2 m/s
响应时间	0-999 秒, 使用者任选。
流速范围	±32 m/s
管段尺寸	20mm-6000mm
测量单位	米，英尺，立方米，升，立方英尺，美国加仑，英国加仑，油桶，美国液体桶，英国液体桶，美国兆加仑，使用者指定单位。
累 积 器	7位正、负、净累积器
液体种类	各种液体
安 全 性	设置值的锁定，更改数据需解锁。
显　示	4x8 中文或 4x16 英文
通讯接口	RS-232C，波特率75- 57600, 同时兼容富士的超声波流量计，也可应用户的要求兼容其它产品。
传 感 器	标准M1型，另有其它3种可供选择。
传感器电缆	标准为5米x2，也可加长为10米x2。
电　源	3 节AAA 内置Ni-H电池，每次充满电可持续工作12小时，100V-240VAC的适配器
数据记录	内置数据记录仪可记录2000行数据。
手动累积器	7位，按键即可开始用于校准。
外壳材料	阻燃ABS
外形尺寸	100x66x20mm
主机重量	516g (1.2 lbs) 包括电池

2. 开始测量

§2.1 内置电池

TDS-100H手持式超声波流量计内置的Ni-H电池在充满电的情况下，可以连续工作超过10个小时，外部的供电则需要充电器。

电池充电电路采用了固定电流和固定的电压。这种方式的特点是开始的快速充电、在电池将要被充满时的缓慢充电方式。当绿灯点亮时表示以充到电池容量的95%，但红灯关闭时，电池以充到98%。

由于电池接近充饱和时，充电电流变得越来越小，所以就不会产生过充的问题。就是说充电过程可能持续很长，当全天候测量时充电器可以一直插着。

当电池充满电时，两端电压可达到4.25V，这个电压值可以在M07号窗口看到。当电池电量将被耗尽时，电池两端电压会低于3V，使用者可以从该窗口粗略地看到流量计生于工作时间。

电池剩余电压工作计时器只是根据电池两端的电压进行计算的，特别注意是在电池电压在3.70 -3.90V时，剩余工作时间只是粗略数，仅供参考和提醒作用。

§2.2 通　电

按 [on] 键打开流量计的电源，按 [off] 键关闭流量计的电源。

当流量计接通电源后，首先运行自我诊断程序，对软硬件进行检测，如存在故障，则显示相应的错误信息。

通常不会有错误的信息显示，流量计会直接进入常用的01号窗口（缩写为M01），显示流速、瞬时流量、正向累积流量值和信号强度、信号良度， 流量计将以上次断电前输入的管道参数或者初次的设置参数为基础进行工作。

流量计的测量工作程序总是在使用界面的后台进行的，就是说流量测量不会因为使用者要进行窗口浏览而停止，只有使用者进行新的管路测量改变参数时，流量计就会按照新的参数工作。

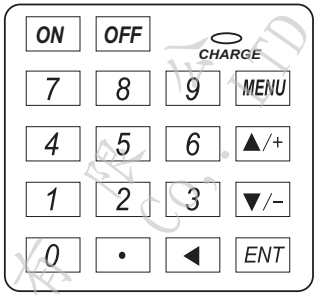
当新的参数被输入时 或打开电源时流量计会进行信号调整放大器增益。通过这一步流量计就会找到最佳收波工作状态。使用者会在LCD显示器的右下角看到有数字1、2、3的过程提示。

当使用者调整已安装好的传感器时，流量计就会自动进行信号调整。

所有输入的参数都会记录在NVRAM 中100年，直到它们被更改。

该流量计不管显示在哪一个窗口上，都会继续进行流量测量和累积。

§2.3 键 盘



如右图所示，键盘采用了16+2键的方式。

键 0 -- 9 和 • 是用于输入数字的。

键▲/+是上箭头/加，使用者按此键可以进入上一级菜单， 也可以用来加数。

键▼/-是下箭头/减，使用者按此键可以进入下一级菜单， 也可以用来减数。

键◄是退格键，使用者按此键可以用于左退格或删除左面字符 。

键ENT是确认键，使用者按此键可以用于对所输入的参数和选择进行确认。

键 MENU 用于访问菜单，无论在哪一个菜单窗口进入任何确定的菜单窗口，按此键然后再键入两位数字即可。

当指定菜单窗口时，键MENU常被缩写为“M”

键 ON 用来打开电源。

键 OFF 用来关闭电源。

§2.4 菜单窗口

用户界面由100个不同的菜单窗口构成： M00, M01, M02 … M99.

有两种方法进入菜单窗口：

(1) 直接进入：使用者可以按 MENU ，再按2个数字键。例如输入M11进入管道外径窗口，MENU 1 1

(2) 通过按▲/+和▼/-键，每按一次▲/+键就会进入上一级的菜单窗口。

例如，当前的窗口是M12，按 ▲/+ 键就会进入M11号窗口。

窗口本身主要分为三种类型：

（1） 数据型：如M11用来输入管道外径的。

（2） 选择型：如M14用来选择管道材质的。

（3） 纯显示窗口：如M00用来显示流速、流量等。

访问数据型窗口，使用者可以直接按数字键输入想要输入的数，例如，当前的窗口是M11，使用者欲输入管道外径参数为219.2345mm，按键顺序如下：

2 1 9 • 2 3 4 5 ENT。

访问选择型窗口，使用者第一步按ENT键进入选择模式，第二步再按 ▲/+ 或▼/- 或数字键来选择想要输入的选项；最后再按ENT键来确认这一选项。例如，M14号菜

单对管道的材质做出选择，(如果是在别的菜单窗口时，就必须按 MENU 1 4 进入M14号窗口)，管道的材质是不锈钢所对应的选项是“1 不锈钢”，使用者第一步按 ENT 键进入选择模式，然后通过按▲/+或▼/-键 将光标移到：“1 不锈钢”，或者直接按 1 键做出选择。

通常，必须按 ENT 键进入选择模式，如果在LCD显示器的最下一行显示为“Locked M47 Open”，意思是修改操作已被上锁，使用者必须进入M47 号菜单后输入密码解锁，然后才能进行修改操作。

§2.5 菜单窗口简介

M00-M09 号窗口是显示窗口，能显示瞬时流量、正累积流量、负累积流量、净累积流量、瞬时流速、日期时间、电池的剩余电压的粗略工作时间。

M10-M29 号窗口是初始参数操作窗口，在这些窗口中输入诸如管道外径、管壁厚度、流体种类、探头类型、探头安装方法等参数，显示安装距离等。

M30-M38 号窗口是流量单位选择和累积器选项操作窗口，在这些窗口中，可以选择工作单位系，可选择流量计工作单位诸如立方米、公升等，可以打开或关闭各累积器或是对其进行“清零”操作。

M40-M49 号窗口设置阻尼时间、校零、修改密码。

M50-M53 号窗口设置测量数据记录操作。

M60-M78 号窗口时钟设置、显示软件版本、电子序列号、警告。

M82　　号窗口浏览数据累积器。

M90-M94 号窗口为准确测量而设置的诊断数据。

M97-M99 号不设窗口显示，它们是进行窗口拷贝输出和管道参数输出的命令。

M+0-M+8 号窗口是附加的功能如：计算器、总的工作时间、上、断电的时间、上、断电的时刻的流量。

有一些的菜单窗口没有赋予功能如：M88，也有一些菜单窗口在本版软件极少用而删除。

之所以这样编排菜单窗口顺序就是想与以前同系列产品的菜单窗口顺序互相一致，极大地方便以前使用过本系列产品的用户。

§2.6 参数设置步骤

为了使TDS-100H型超声波流量计达到正确的测量，使用者必须按照下列的步骤进行参数的设置：

管道外径

管道壁厚

管道材质 (非常用的管道材料的声速需要输入)

常用的管道材料的声速已经作为标准事先被写入软件中，所以使用者不必要再输入了。

衬里材料和它的声速与厚度， 如果有衬里的话。

液体种类 (非常规的液体需要知道它的声速)

本流量计所配置的传感器类型, 一般是标准中支架探头，其它类型的传感器使用者可根据实际情况定货时选择购买。

打算采用何种方式安装传感器 (V法和Z法是通常采用的两种方式)

查看M25 窗口所显示的传感器的安装距离

对于标准（常见的）管道材质和标准（常见的）液体的设置的步骤如下：

(1) 按 MENU 1 1 键进入M11窗口输入被测管道的外径，按ENT键。

(2) 按 ▼/- 键进入 M12窗口输入管道壁厚，按ENT键。

(3) 按 ▼/- 键进入 M14窗口，按ENT键进入选择模式，按▲/+ 键或▼/-键向前或向后浏览找到被测管道的材料，按ENT键确认。

(4) 按▼/- 键进入 M16窗口，按ENT键进入选择模式，按 ▲/+ 键或 ▼/- 键向前或向后浏览找到被测管道的衬里材料，按ENT间确认。或者无衬里时选“无衬里”。

(5) 按▼/- 键进入M20窗口，按 ENT 键进入选择模式，按 ▲/+ 键或▼/- 键向前或向后浏览找到被测液体，按ENT 键确认。

(6) 按▼/- 键进入 M23窗口，按ENT键进入选择模式，按 ▲/+ 键或 ▼/- 键向前或向后浏览找到本流量计所配置的传感器，按ENT键确认。

(7) 按▼/- 键进入 M24窗口，按 ENT 进入选择模式，按▲/+ 键或 ▼/- 键向前或向后浏览找到你想要安装探头的方式，按ENT键确认。

(8) 按 ▼/- 键进入 M25窗口，按照所显示的距离将传感器安装在被测管道上，按 ENT 键进入M01查看测量结果。

初次使用者应该有一点耐心，不久你就会发现本仪器的使用界面非常容易掌握，只须轻按动几个键，就会进入你想要进行的窗口操作，而不需要多余的操作。

使用中的小技巧：

当窗口显示在 M00 到 M09时，按任意一个数字键 x ，即可直接进入 M0x号窗口。例如，当前的窗口是M01 ，按 7 键直接跳到M07 号窗口。

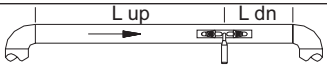
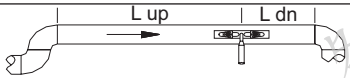
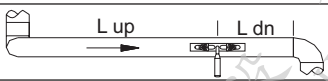
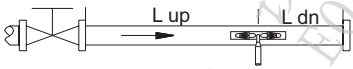
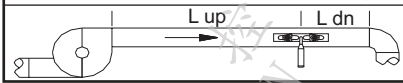
当窗口显示在 M00 到 M09时， 按 ENT 键直接进入 M90号窗口，再按 ENT 键就会返回原窗口。按 . 键就会进入M11号窗口。

当窗口显示在 M25时，按 ENT键就会进入M01号窗口。

§2.7 传感器安装位的选择

首先，使用者要选择一个合适的测量管段，为了获得有效的测量数据，一些有关被测管道和泵系统的基本状况要事先了解清楚。

确定合适的测量管段的原则是：管道中的液体必须是满管而且要有足够的直管段长度。下图示例如何正确定位。

Piping Configuration and Transducer Position	Upstream Dimension L up x Diameters	Downstream Dimension L dn x Diameters
	10D	5D
	10D	5D
	10D	5D
	12D	5D
	20D	5D
	20D	5D
	30D	5D

正确选择测量位置的原则：

安装传感器位置的管路要有足够长的直管段，当然越长越好，一般上游10倍管直径，下游5倍管直径，离泵出口30倍管直径；同时保证这段管路里的液体一定是满贯的。

确定被测管路的温度范围是在传感器的使用温度范围内，通常在室温状态下最佳。

把管道的锈蚀或结垢情况考虑进来，最好选择较新一点的管道测量，如果条件不具备就把锈蚀从管壁厚度中减去或者将结垢当作衬里来考虑。

有一些管道有塑料衬里，并且由于管道的制造工艺原因，在管道内壁与衬里之间有可能存在缝隙，这样就会阻挡超声波的传播，使测量变得非常困难，所以使用者要尽量避免在这样的管道上测量；如果避免不了，就必须使用我公司生产的插入式传感器，可以在管道不停流、带压的情况下打孔安装，解决收不到信号的难题。

§2.8 传感器的安装

TDS-100系列超声波流量计的传感器使用的一对收发两用的压电陶瓷片，它们能够发射和接收穿过管道和液流的超声波信号，测量流量是通过测量发射和接收超声波的不同时间的差值来完成的。由于这个差值非常小，所以传感器之间的距离和平行度会影响到测量精度，使用者应该特别认真仔细的安装传感器。

安装传感器的步骤

选择有足够直管段长度位置，最好是新管道、无锈蚀、易于操作的地方。

清除管道上的杂物和锈蚀，最好使用角磨机打掉锈蚀。

在传感器的发射面上涂上足够多的耦合剂（如：黄油、凡士林等），涂耦合剂的目的是排除传感器发射面与管道外表面之间的空气。

特别提醒：应避免沙粒和杂物进入这中间。

水平方向的管道内壁上部有可能残存着一些气泡，在这样的管道上安装时应选择在与管道的侧面垂直相切的面上。

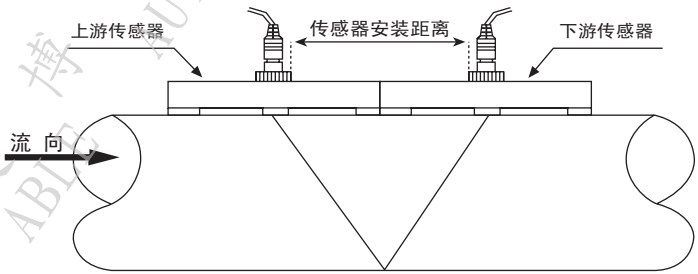
§2.8.1 传感器的安装距离

传感器的安装距离是在M25号窗口中显示的数值，它是指两只传感器的内侧距离，要想准确测量，使用者应按照显示的距离数值安装传感器。

§2.8.2 V方式安装传感器

V方式安装传感器是在常用的方法，一般建议在20-300mm的管道上使用，它有时被称为反射法。

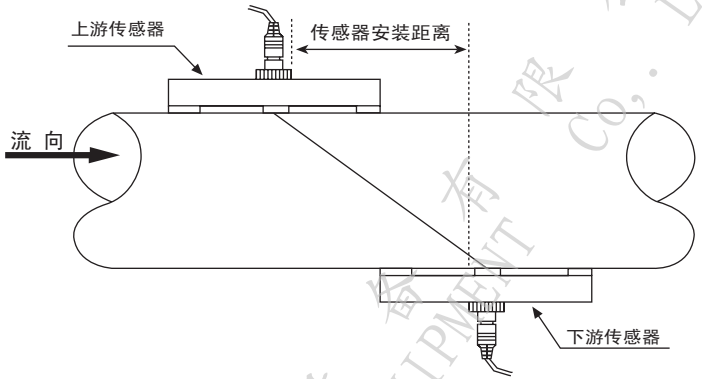
管道顶视图



§2.8.3 Z方式安装传感器

一般Z方式是在100mm以上的管道上使用，它有时被称为直接法。

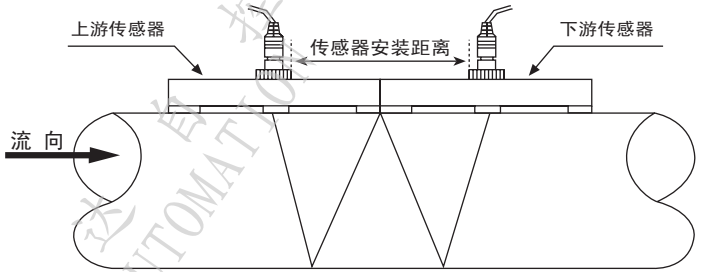
管道顶视图



§2.8.4 W方式安装传感器

W方式通常被用在10-100mm的管道上。

管道顶视图



§2.8.5 N方式安装传感器

极少用的方式。

§2.9 检查安装

使用者在安装好传感器后要对下列项目进行检查：收信号强度、信号良度Q值、时差、估测的液体声速、信号传输时间比等。只有这样流量计才能稳定运行、测量准确。

§2.9.1 信号强度

信号强度是指接收到的、经过放大的超声波信号，用3位数表示：[000] 是指未检测到任何的信号；[999] 是指接收到的信号最大。

尽管信号在500-999之间流量计都能工作，但是较强的信号强度就能得到好的测量结果，所以使用者应当将传感器接收到的信号条道最大。建议按下列方式做就能得到较好的信号强度：

(1) 如果测得流量数值不稳定、信号强度低于700时，重新选择较好的测量位置。

(2) 仔细地打磨管道的外表面，稍微多加一些耦合剂。

(3) 轻微调整传感器的相对位置同时观察流量计的接收信号强度，停在信号最大的位置，同时也要检查传感器之间的距离是否满足M25窗口的显示要求。

§2.9.2 信号质量（信号良度）

流量计的信号质量是用Q值来表示的。Q值大意为着较高的信噪比（缩写SNR），当然测量的数据也比较准确，Q值应该在600-900范围之间，越高越好。

Q值较低可能有下列几种原因：

被附近的其他设备或装置干扰，如变频器的干扰就很强。解决办法是：重新选择安装位置、远离干扰源、做好屏蔽、不共用电源等。

传感器与管道耦合不好，应该重新打磨、重涂一些耦合剂。

被测管段比较难测量，需要重新选择测量点。

§2.9.3 总的传输时间和时差

总的传输时间和检测到的时差被显示在菜单窗口M93号中，它们是参与计算管道流量的基本数据，所以流量将随着总的传输时间和时差变化而变化。

总的传输时间的变化范围应该很小。

当时差的上下波动范围超过了20%表示在传感器的安装方面存在问题，使用者应检查。

§2.9.4 传输时间比

这个数值常被用来检查传感器安装的是否正确、输入的管道参数是否与实际的情况相符。如果管道参数与传感器的安装正确，这个数值应该在100±3的范围内。 超标了使用者就应该检查：

已输入的管道的参数是否正确，与实际是否相符。

传感器的安装距离是否如M25号窗口所示？

传感器的安装方向是否正确？

传感器的安装位置是否合适？被测管段是否变形？内部是否存在着干扰源？

检查其它不符合测量要求的方面。

3. 怎样使用

§3.1 怎样判断流量计是否工作正常

一般情况下，在液晶显示器的右下角有"R"出现，表示流量计工作正常。

如果出现"H"时，则表示收到的信号比较差，请参考自诊断章节。

如果出现"I"时，则表示没有收到信号。

如果出现"J"时，则表示该流量计可能出现了硬件故障，请参考自诊断章节。I

§3.2 怎样判断管道内的液体流动方向

确定目前流量计工作正常。

查看瞬时流量，如果显示的是正值，表示液流的方向是从红色传感器流向蓝色的传感器；如果显示的是负值，表示液流的方向是从蓝色传感器流向红色的传感器。

§3.3 怎样改变系统的测量单位制

在M30号菜单窗口中选择使用英制或者公制。

§3.4 怎样选择流量单位

在M31号菜单窗口中选择。

选择完流量单位然后选择时间单位。

§3.5 怎样选择累积器倍乘因子

使用33号窗口中选择一个合适的累积器倍乘因子，要根据流量大小来确定不要太快也不要太慢，最好是保持在一分钟几个脉冲。

如果倍乘因子太小就会发生丢失脉冲的现象，因为设计的最小的脉冲周期为500毫秒。

如果倍乘因子太大累积脉冲就会太慢，会影响到其它的二次仪表的工作。

§3.6 怎样打开和关闭累积器

使用34、35、36号窗口分别对正、负、净累积器进行打开或关闭的操作。

§3.7 怎样实现流量累积器清零

使用37号窗口选择欲清零累积器进行清零。

§3.8 怎样恢复出厂设置

使用37号窗口中显示为“选择操作”时，按[•]键，再按[◀]键即可，使用者输入的参数恢复到原始的出厂设置。

§3.9 怎样使用阻尼器稳定流量显示

阻尼器的作用是稳定流量显示，其本质是一节滤波器。在M40窗口中输入“0”，表示没有阻尼。当然数值越大流量计显示的瞬时流量越稳定，一般建议使用者输入的数值在30秒左右，这个数值的大小不会对累积流量产生任何影响。

§3.10 怎样使用零点切除避免无效累积

窗口41中的数据称为低流速切除值。流量计把流速绝对值低于此值的流量视为“0”对待。这样可设置此参数，避免真实流量为“0”时，流量计产生的测量误差进行虚假的累积。一般情况下，设置此参数为0.03m/s。

当管道流体的实际流速大于低流速切除值后，低流速切除值和测量结果无关，绝不影响测量结果。

§3.11 怎样静态校准零点

当管道内的液流完全停止时，流量计不会显示为“0”，而是有一个很小的“零点值”，此时就可以设置零点已达到精确测量的目的。

统过M42号窗口来完成此项功能。

要求却认管道内的液流一定要完全停止流动后，进入M42号窗口，按[ENT]即可开始。

§3.12 怎样修改仪表系数（标尺因子）标定校准

标尺因子是“真实流量”与流量计测得流量的比值。

标尺因子可以通过标定装置的实流检测能得到。.

§3.13 怎样使用密码保护

给流量计加上密码锁保护可以避免无关人员错误修改和对累积器清零。

流量计加上密码锁可查阅数据，但不能进行任何修改操作。

M47窗口中输入的密码可以由1-4位的数字组成；无密码上锁可直接按[ENT]键，M47解锁时也直接按[ENT]键。

使用者忘记密码，请与生产商联系，并且要出示身份证明。

§3.14 怎样使用内置数据记录器

内置数据记录器由24K字节的空间，可以存储2000行的数据。

使用M50号窗口打开数据记录器同时选择想要记录的项目。

使用M51 号窗口设置记录数据的开始时间、记录的间隔时间和记录的持续时间。

使用M52 号窗口选择数据存储方向，流量计可以将数据存储在缓冲器中。

数据也可以被传送到RS-232C接口处，不用存到缓冲器中。

使用M53 号窗口可以浏览存在缓冲器中的数据。

使用M52号窗口清除RS-232C接口和缓冲器中的数据。

§3.15 怎样使用频率输出功能

所有的TDS-100型系列超声波流量流量计都具有频率信号输出功能，联网到其它设备上用频率的高低表示瞬时流量的大小，

频率输出任由使用者自行设置，只需设定4个参数。

在M68号窗口中设定瞬时流量的下限值，在M69号窗口中设定瞬时流量的上限值。

在M67出任由使用者自行设置，只需设定4个参数。

在M68号窗口中设定频率范围。

例如：某管道流量范围为0~3000m3/h，要求输出对应频率信号200~1000Hz。 使用者在M68号窗口中输入0，M69号窗口中输入3000，在M67号窗口中输入200和1000。

请注意使用者还要在M78号窗口中选择第13号选项“频率输出”，同时也要做好OCT输出的硬件连线。

§3.16 怎样设置累积脉冲输出

每流过一个单位流量，TDS-100H型超声波流量计可以产生一个累积脉冲输出到外部计数设备。

流量单位及倍乘因子的设置见§3.4、§3.5。

累积脉冲只能通过硬件OCT 或者蜂鸣器。

例如：想要使用蜂鸣器输出正向累积脉冲，每一个脉冲代表0.1m3的流量，这样管道内每流过0.1m3 的液体蜂鸣器就会响一下。

请按下列步骤操作：

在窗口M32中选择累积流量单位：“立方米（m3）。

在窗口M33中选择倍乘因子：“ x 0.1”

在窗口M77中选择:“正累积脉冲输出”。

§3.17 怎样产生输出报警信号I

超声波流量计能产生两类报警信号：声音报警信号和开关输出报警信号。

下列情况能作为蜂鸣器和开关输出的触发源：：

探头接收不到超声波信号。

探头接收超声波信号太差。

流量计没有进入正常测量状态。

流量反向。

频率信号超量程。

瞬时流量超出设定范围。

报警器有两个，分别称为：报警器#1和 报警器#2。使用者在M73, M74, M75, M76号窗口中设置输出范围。

例如：当流量小于300 m3/h和大于2000 m3/h 时，蜂鸣器鸣响，设置过程如下：

在M73号窗口中输入下限流量300作为#1报警器触发点。

在M74号窗口中输入上限流量2000作为#2报警器触发点。

在M77号窗口中选择“6. #1报警器”。

§3.18 怎样使用蜂鸣器

TDS-100H手持式超声波流量计内置蜂鸣器是可编程的，在M77号窗口中进行设置。

§3.19 怎样使用OCT输出

TDS-100H手持式超声波流量计的OCT输出开闭条件是可编程的，如累积脉冲输出等。

在M77号窗口中进行设置。

请注意频率输出信号也是从OCT输出的。

OCT输出与RS-232C 共用一个接口， 接头是6脚，地是5脚。

§3.20 怎样修改日期时间

日期时间一般情况下无需修改，时钟的功耗很小。

只有在电池的电量完全被耗尽而且花费很长时间来更换电池的情况下才需要修改日期。

在M61号窗口中修改日期时间，可以是[•]键跳过不需要须改的部分。

§3.21 怎样调整LCD显示器的对比度

在M70号窗口中进行LCD的对比度调整，调整的结果被存在EEPROM中，恢复出厂设置也不会要调整结果。

§3.22 怎样使用RS232/RS485串行口

在M62号窗口中进行RS-232C 串行口的设置。

§3.23 怎样查看每日、每月、每年流量

在M82号窗口中可查阅过去的日、月、年的历史流量数据和机器工作状态。

§3.24 怎样使用工作计时器

使用工作计时器可以对一项操作进行计时，例如它可以对电池充满电后能连续工作多少时间进行计时。

在M82号窗口中按 ENT 键，选择“是”对计时器复位。

§3.25 怎样使用手动累积器

在M38号窗口中按 ENT 键开始累积，再按 ENT 键停止。

§3.27 怎样了解电池剩余电量的工作时间

在M07号窗口中查看，请参见§.2.1章节的说明。

§3.28 怎样给电池充电

请参见§.2.1章节的说明。

§3.26 怎样查看电子序列号和其他细节

TDS-100H型手持式超声波流量计使用唯一的电子序列号（ESN）来区分每一台流量计，电子序列号是由8位识字组成，包含了软件版本和生产日期信息。

使用者也可以利用这个电子序列号进行设备的管理。

这个电子序列号在M61号窗口中显示。

使用窗口M+1可查阅自流量计出厂以来，总的工作时间。

使用窗口M+4可查阅自流量计出厂以来，上断电总次数。

4. 菜单窗口详解

菜单窗口号码	功 能
M00	显示正、负、净累积，信号强度，信号良度和工作状态。
M01	显示正累积，瞬时流量，流速，信号强度，信号良度和工作状态。
M02	显示负累积，瞬时流量，流速，信号强度，信号良度和工作状态。
M03	显示净累积，瞬时流量，流速，信号强度，信号良度和工作状态。
M04	显示时间日期，瞬时流量，信号强度，信号质量和工作状态。
M05	显示时间日期，流速，信号强度，信号良度和工作状态。
M06	显示收到的波形。
M07	显示电池两端剩余电压和估计剩余的工作时间。
M08	显示所有的工作状态，信号强度和信号良度。
M09	显示今天全天的净累积流量，流速，信号强度，信号良度和工作状态。
M10	输入被测管道的外周长。
M11	输入被测管道的外径。 允许输入的数值范围是0-6000mm
M12	输入被测管道的壁厚。
M13	输入被测管道的内径（管外径和壁厚输入正确后内径大小自动算出，可跳过此窗口）。
M14	选择被测管道的材质类型 下列管道材质时常用的，使用者不需要输入它们的声速： (0) 碳钢 (1) 不锈钢 (2) 铸铁 (3) 球墨铸铁 (4) 铜 (5) PVC (6) 铝 (7) 石棉水泥 (8) 玻璃钢
M15	用来输入不常见的材质制成管道的声速
M16	选择衬里材质类型，如果管道没有衬里请选择“无衬里” 常见的衬里材质如下，使用者不需要输入它们的声速： (1) 环氧沥青 (2) 橡胶 (3) 灰浆 (4) 聚丙烯 (5) 聚苯乙烯（Polystryol） (6) 聚苯乙烯（Polystyrene） (7) 聚酯 (8) 聚乙烯 (9) 硬质橡胶胶木 (10) 聚四氟乙烯
M17	用来输入不常见的材质制成衬里的声速。
M18	输入有衬里管道的衬里厚度。
M19	输入管道内壁的粗糙系数。
M20	选择流体种类

M20	常见的流体如下，使用者不需要输入它们的声速： (0) 水　(1) 海水　(2) 煤油　(3) 汽油　(4) 燃料油　(5) 原油 (6) 丙烷（-45度）　(7) 0度丁烷　(8) 其它　(9) 柴油　(10)蓖麻油 (11)花生油　(12) 90号汽油　(13) 93号汽油　(14) 酒精　(15) 125度高温水
M21	用来输入不常见流体的声速。
M22	用来输入不常见流体的粘度。
M23	选择本机配置的传感器 以共有14种类型的传感器可供选择： 如果选择了用户自备的传感器，则需要输入传感器的4个参数 如果选择了π型管段式传感器，则需要输入传感器的3个参数
M24	选择传感器的安装方法 有4种方法可供选择： (0) V-方安装　(1) Z-方安装　(3) N-方安装　(4) W-方安装
M25	显示传感器的安装距离。
M26	将管道的参数存储道内部的nvram 中。
M27	读取以前存储的管道参数 。
M28	选择当收到的信号变差时是否保持上次的正确数据，出厂设置为“是” 。
M29	输入一个数值000-999之间表示多少为信号质量差，出厂设置0。
M30	选择测量的单位制，出厂设置为“公制”，英制与公制转换不会影响累积的单位。
M31	选择流量单位，下列单位可供选择： 0. 立方米　缩写为 (m3) 1. 升　(l) 2. 美国加仑　(gal) 3. 英国加仑　(igl) 4. 美国兆加仑　(mgl) 5. 立方英尺　(ct) 6. 美国液体桶　(bal) 7. 英国液体桶　(ib) 8. 油桶　(ob) 时间单位有：/天、/小时、/分钟、/秒，可以组合为36种流量单位
M32	选择累积流量的单位。
M33	选择累积的倍乘因子。 倍乘因子的选择范围为 0.001 到 10000

M34	净累积器开关。
M35	正累积器开关。
M36	负累积器开关。
M37	(1) 累积器清零 (2) 恢复出厂设置，按点键再按左箭头键完成，小心操作恢复出厂参数设置。
M38	手动累积器，按任意键开始按任意键停止。
M39	选择显示语言中文或英文， 此项操作使世界上超过20亿人可以看懂流量计的显示内容。
M40	阻尼系数，设置范围0-999秒。 0秒表示无阻尼，出厂设置是10秒。
M41	低流速切除值，避免无效计量 。
M42	静态置零，使用时注意被测管道内液流完全停止。
M43	清除静态置零零点，恢复到出厂的原始零点。
M44	手工零点设置，通常情况下设置为零。
M45	标尺因子仪表系数，出厂设置系数为1。 没经过实流标定时系数是1。
M46	网络标识地址码， 除了13(0DH, 回车), 10 (0AH, 换行), 42 (2AH), 38, 65535之外的任何整数都可以。每一台流量计都有一个联网用的地址码IDN,，请参见通讯章节的说明。
M47	系统锁，密码保护防止参数被更改。
M48	没有使用。
M49	联网通讯测试窗口 。
M50	数据定时输出选项，内置数据记录器的开关。
M51	定时输出时间设置。
M52	输出数据流向控制，如果选择“缓存=> RS-232”， 所有记录的数据全都被送至RS-232接口。 如果选择“存入机内缓存”，数据就被存入内置的记录器中。 清除内置缓存。
M53	缓存浏览器，它的作用如同一个文件编辑器，用 [·]、[◀]、[▲/4] 或 [▼/-] 键浏览缓存器。 当记录器是打开的时候，只要有新的数据存储，浏览器就会自动更新。
M54	没有使用。
M55	没有使用。
M56	没有使用。

M57	没有使用。
M58	没有使用。
M59	没有使用。
M60	99年的日历设置，按[ENT]键进行修改，使用[•]键跳过不需要修改的数字。
M61	流量计的版本信息，本台流量计的电子序列号。 使用者可以利用这个电子序列号进行设备的统计和管理。
M62	RS-232串行口设置，波特率的范围是75-115200bps。
M63	没有使用。
M64	没有使用。
M65	没有使用。
M66	没有使用。
M67	使用频率输出功能，输入频率范围是0-9999Hz，出厂设置是1-1001 Hz。
M68	频率输出下限量值。
M69	频率输出上限量值。
M70	LCD 液晶显示器的显示背光控制选项，输入的数值表示背光可以电亮多少秒钟。
M71	LCD 液晶显示器对比度控制，输入的数值越小LCD的显示越暗淡。
M72	工作时间定时器，按 [ENT]键然后选择“YES”可以将其清零。
M73	#1报警器下限设置，本流量计配备了两套报警方式，使用者同时必须在M77或M78窗口中选择报警输出的内容。
M74	#1报警器上限设置。
M75	#2报警器下限设置。
M76	#2报警器上限设置。
M77	蜂鸣器设置选项 。 通过选择适当的触发事件，当事件发生时，蜂鸣器辉发出“叱叱”的声音。
M78	OCT (集电极开路输出) 开路输出选项。 通过选择适当的触发事件，当事件发生时，OCT 电路就会接通。
M79	没有使用。
M80	通过RS-232接口与另一台手持式联机用做它的键盘显示器。
M81	没有使用。
M82	日月年流量累积器。
M83	没有使用。
M84	没有使用。

M85	没有使用。
M86	没有使用。
M87	没有使用。
M88	没有使用。
M89	没有使用。
M90	显示信号强度，信号质量，右上角的是传输时间比。
M91	信号传输时间比，如果被测管道的参数输入正确，而且传感器安装也合适，这个数值应该在100±3%范围内，否则使用这就应该检查输入的参数和传感器的安装。
M92	显示估测流体声速，如果这个数值与实际流体的声速差异很大，使用这就有必要检查已输入的管道参数和传感器的安装是否正确。
M93	显示信号总的传输时间和时差。
M94	显示流量测量程序使用的雷诺系数及管道因子。
M95	没有使用。
M96	没有使用。
M97	命令将输入的管道参数存入内置的数据缓存器和RS-232C串口。
M98	命令将自诊断的信息存入内置的数据缓存器和RS-232C串口。
M99	命令将当前显示窗口内容存入内置的数据缓存器和RS-232C串口。
M+0	查阅前64次的上、断电时刻的时间和流量数据。
M+1	显示流量计总的工作时间。
M+2	显示上次断电时间。
M+3	显示上次断电时流量。
M+4	显示流量计总开关次数。
M+5	科学型计算器，方便适用。 运算符是通过选择而不是直接按键。
M+6	没有使用。
M+7	没有使用。
M+8	没有使用。
M+9	没有使用。
M-0	生产商的硬件调整入口。

5. 问题处理

§5.1 硬件上电自检信息及原因对策

TDS-100型系列超声波流量计在每次上电的时候都要对硬件进行自诊断，下表是上电后显示的信息及解决对策：

故障信息	原　因	解决对策
ROM 检验错误 数据测试错误	软件有误	(1)重新上电 (2)同厂商联系
存储数据错误	使用者输入的参数丢失	出现此信息时按 ENT 键，所有参数恢复出厂时设置
主频或时钟慢错误 主频或时钟快错误	时钟故障或晶振故障	(1) 重新上电 (2) 同厂商联系
日期时间错误	系统日期时间有错	在M61号窗口重新输入时间
主机重复复位	硬件系统错误	同厂商联系

§5.2 工作时错误代码（状态代码）原因及解决办法

TDS-100型系列超声波流量计都会在显示器右下角显示一个状态代码如：大写的I、R等。下表是在M00，M01，M02，M03，M90 和 M08号窗口中显示的状态代码的含义及解决办法：

错误代码	M08菜单对应显示	原　因	解决办法
R	系统工作正常	没有错误	
I	没有检测到接收信号	(1) 收不到信号 (2) 传感器安装不合适 (3) 传感器与管道接触不紧或耦合剂太少 (4) 管道的结垢太厚或者衬里太厚 (5) 传感器连接电缆断了	重新更换测量位置清除结垢 检查电缆的连接情况 检查耦合剂
J	测量电路硬件错误	硬件故障	与厂商联系
H	接收信号质量差或者低	(1) 信号低 (2) 传感器安装不合适 (3) 管道的结垢太厚 (4) 管道的衬里太厚 (5) 传感器连接电缆断了或者接触不好	(1)重新更换测量位置 (2)清除结垢 (3)检查电缆的连接情况 (4)检查耦合剂

Q	频率输出高于设定值	实际的频率输出超出了使用者的设定值	在M66，M67，M68和M69船口中输入的数值，并在M69窗口中输入一个较大的数值。
F	存储数据错误 日期时间错误 CPU或IRQ错误 ROM 错误	(1) RAM，RTC地暂时性错误 (2) 永久性硬件故障	(1) 重新上电 (2) 同厂商联系
1 2 3	自动增益调整	流量计进行自动增益调整，数字表示调整的步骤	
K	空管	管道内无流体 在M29窗口中设置错误	重新选择满管的地方测量 在M29窗口中进行设置空管信号

§5.3 其他常见问题问答

(1) 流量计的显示测量正常的“R ”，并且收到的信号强度和信号良度都很好，被测管道的流体一直在流动，而此时流量计的流量一直显示为0.0000，这是什么原因？

使用者有可能在有流体流动的情况下使用了“静态置零”操作；解决办法是进入M43号窗口“清除静态置零零点”选择“是（YES）”。

(2) 流量计显示的流量数据比管道是流量小或者大，这是什么原因？

（a）在M44窗口中进行了错误的设置；解决办法是进入M44号窗口输入数值“0”。

（b）传感器安装的不正确。

（c）流量计存在一个零点，在确认管道内的流体完全静止的情况下，进入到M42号窗口中进行“静态置零”操作。

(3) 机内电池剩余电量的工作时间没有达到M07号窗口中显示时间长度。

（a）电池的充放电次数已经达到了使用寿命，需要更换。

（b）新更换的充电电池可能与软件计算程序不配套，软件需要升级，请与厂商联系。

（c）电池在充电的过程中，被中断过很多次，导致电池未能充满电。

（d）机内电池剩余电量的工作时间确实与实际的工作时间有一定差异，特别是电池两端电压在3.70-3.90v之间时。所以机内电池剩余电量的工作时间仅供使用者参考。

6. 联网使用及通信协议

§6.1 概述

TDS-100型系列超声波流量计都配备一个标准的RS-232C通讯借口，还有一套完整的通讯协议，而且与日本富士电机超声波流量计的通讯程序想兼容。

§6.2 流量计串行口定义

针	1	电池充电正极
	2	收RXD
	3	发TXD
	4	空
	5	地GND
	6	OCT输出
	7	空
	8	电池充电负极
	9	连接调制解调器的RING 输入

§6.3 通信协议

通信协议是一些基本命令采用数据字符串（ASCII），结尾是回车 (CR) 和换行 (LF)，常用命令如下表所示：

命 令	命令意义	数据格式
DQD(CR)	返回每天瞬时流量	±d.dddddd E±dd(CR) (LF)*
DQH(CR)	返回每小时瞬时流量	±d.dddddd E±dd(CR) (LF)
DQM(CR)	返回每分瞬时流量	±d.dddddd E±dd(CR) (LF)
DQS(CR)	返回每秒瞬时流量	±d.dddddd E±dd(CR) (LF)
DV(CR)	返回瞬时流速	±d.dddddd E±dd(CR) (LF)
DI+(CR)	返回正累积量	±ddddddd E±d(CR) (LF)**
DI-(CR)	返回负累积量	±ddddddd E±d(CR) (LF)
DIN(CR)	返回净累积量	±ddddddd E±d(CR) (LF)
DID(CR)	返回仪器标识码（地址码）	ddddd(CR) (LF)
DL(CR)	返回信号强度和信号良度	S=ddd,ddd Q=dd (CR) (LF)

DT(CR)	返回当前日期及时间	yy-mm-dd hh:mm:ss(CR)(LF)
M@(CR)***	发往流量计模拟键值@	
LCD(CR)	返回当前LCD显示器显示内容	
FOdddd(CR)	使频率输出以n值输出	
ESN(CR)	返回流量计的电子序列号	Ddddddddd(CR)(LF)
RING(CR)	调制解调器请求握手命令	
OK(CR)	调制解调器应答信号	无输出
GA	GSM短信息通信专用命令A	详细请与厂商联系
GB	GSM短信息通信专用命令B	
GC	GSM短信息通信专用命令C	
DUMP(CR)	输出机内打印缓冲区内容	ASCII码格式
DUMP0(CR)	清除机内打印缓冲区	ASCII码格式
DUMP1(CR)	输出机内打印缓冲区全部内容	ASCII码格式， 24K字节长
W	单字节地址组网命令前缀，单字节地址应该在0-65534之间。	
N	数字串地址（IDN）组网命令前缀，数字串地址（IDN）可以是一个单字节数值，应该在00-255之间。	
P	带校验回传命令前缀	
&	命令“加”功能符号，可以将6个基本命令连接起来形成一个长复合命令	

注释　　*　　(CR) 表示回车，(LF) 表示换行。

**　　‘d’ 表示0~9数字。

***　　@ 表示键值，例如30H,表示“0”键。

§6.4 功能前缀和功能符号

P前缀

字符P可以加在每一个基本命令前，表示回传的数据带有CRC校验。校验和的求法是二进制加法得到的。

例如：命令 DI+（CR）（相应二进制数据为 44H,49H,2BH,0DH）回传的数据为+1234567E+0m3 （CR）（LF）(相应二进制数据为2BH, 31H, 32H, 33H, 34H, 35H, 36H,37H,

45H,2BH,30H,6DH,33H,20H,0DH,0AH)则命令PDI+(CR) 回传的数据为 +1234567E+0m3 ! F7(CR)（LF）, "!"表示其前是求和的字符，其后两个字节的校验和：

(2BH+31H+32H+33H+34H+35H+36H+37H+45H+2BH+30H+6DH+33H+20H=(2)F7H)

注意"!"前可以没有数据，也可能存在空格符号(20H)。

W前缀

W前缀的是用与联网的环境中，用法是：W+数字串地址码+基本命令，数字串取值范围0-65534除去 13（0DH回车），10（0AH换行），42（2AH *），38（26H&）。如欲访问第 12345号流量计的瞬时流速，可发命令 W12345DV(CR), 对应二进制码为57H,31H, 32H,33H,34H,35H,44H,56H,0DH。

数字串应该在0-65534之间，除了13(0DH), 10 (0AH), 42(2AH,*), 38(26H, &)之外。

例如： 流量计的数字串地址码IDN=12345 ，要求返回瞬时流速的命令是：W12345DV (CR)。

N前缀

N前缀是用于网络的一个单字节地址码，不推荐使用，保留它只是保持本产品与以前的版本的兼容一致性。

& 功能符号

& 功能符号可以把多至六个的基本命令（可带前缀P）加在一起组成复合长命令，使编程更容易。

例如要求同时第4321号流量计发回 1.瞬时流量 2.瞬时流速 3.正累计量，并且带校验，发送的复合命令如下： W4321DQD&DV&DI+(CR)

回传的数据如下：

+1.234567E+12m3/d(CR)

+3.1235926E+00m/s(CR)

+1234567E+0m3(CR)

§6.5 键值编码

键值编码，在上位机模拟按键用途。例如通过串行口输入指令“M1”，即相当于TDS-100键盘上按键 1 ，这样可达到在上位机完全实现键盘操作的所用功能。所有键盘编码如下表所示。

键值编码用于使用联机时，将“M”与键码一起输入，即相当于直接在流量计键盘上操作一样，使用这个功能就可以实现遥控操作，甚至可以通过互联网远程操作流量计。

按键	键值码（十六进制）	键值码（十进制）	ASCII码
0	30H	48	0
1	31H	49	1
2	32H	50	2
3	33H	51	3
4	34H	52	4
5	35H	53	5
6	36H	54	6
7	37H	55	7

按键	键值码（十六进制）	键值码（十进制）	ASCII码
8	38H	56	8
9	39H	57	9
•	3AH	58	:
◀	3BH,0BH	59	;
MENU	3CH,0CH	60	<
NET	3DH,0DH	61	=
▲/+	3EH	62	>
▼/−	3FH	63	?

7. 质量保证及服务维修支持

§7.1 质量保证

本公司的所有产品实行一年的免费保修服务，使用者只需承担将流量计发回本公司的单向运费。

§7.2 公司服务

本公司为所有的用户提供安装服务，所需安装费用根据实际花销结算。

如果遇到了流量计硬件故障，我们建议使用者将流量计发回我公司进行维修服务，因为流量计是由微处理器构成，很难进行现场维修，将流量计发回我公司以前最好与维修人员联系一下确认故障现象。

其它使用中的问题，使用者可以通过电话、传真或电子邮件与我公司的维修部门联系解决。

§7.3 软件升级服务

本公司提供免费的软件升级服务，请与我们联系最新的软件产品。

Contents

1. Introduction

§1.1 Preface

Welcome to the TDS-100 (Version 8.xx) series ultrasonic flow meter that has been manufactured with patent technologies and is equipped with more functions and advanced performance than our previous versions.

The Version 8.xx series ultrasonic flow meter has been upgraded based on the Version 7.xx series ultrasonic flow meter, which is still the main product line of the company. The new Version 8.xx retains most of the excellent features and functions of the previous versions: the pulse measurement technology, the ultrasonic igniting and the small signal receiving circuits etc. The main improvements are made on the battery supply circuit and on the transmitting circuits. All other circuits are simply integrated into this new version without major modifications, due to the fact that we have already applied the most advanced measurement technologies and attained a more reliable model of ultrasonic flow meter.

The TDS-100 Series flow meter incorporates the latest ICs manufactured from the famous semiconductor manufacturers like Philips, Maxim, TI, Winbond, and Xilinx. The hardware features the ease of operation, high accuracy and outstanding reliability, while the software provides a very user friendly interface and much more functions. It employs a patent balanced lower voltage multi-pulse igniting circuit which increases the anti-interference ability magnificently so that the flow meter will work properly even in demanding industrial environments such as those with power frequency transverter working nearby.

Other outstanding features:
----the signal receiving circuits feature self-adapting performance so as to ensure that the user can easily operate the instrument without any adjustment.

----the built-in rechargeable Ni-H battery can work continuously for more than 12 hours without recharge.

The advanced circuit design, the integration of the latest semiconductors, the user-friendly software interface both in English and Chinese languages and small-sized PCB board, all these features combine to make the TDS-100 series ultrasonic flow meter the best and the biggest seller on the Chinese market. Moreover, it is gaining more and more recognition on the international flow meter market

§1.2 Features

* 0.5% of linearity
* 0.2% of repeatability
* Bilingual interface in Chinese and English
* 4 flow totalizers

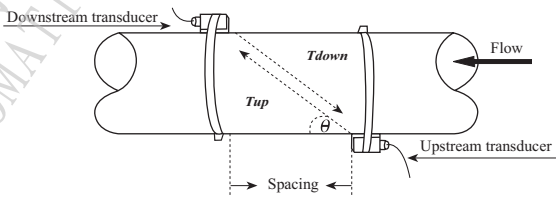
* Patent balanced lower-voltage multi-pulse ultrasonic igniting
* Work properly near transverters
* 100 Pico-second resolution of time measurement
* built-in date totalizers
* built-in data-logger
* 0.5 second totalizing period

§1.3 Principle of Measurement

The TDS-100 ultrasonic flow meter is designed to measure the fluid velocity of liquid within a closed conduit. The transducers are a non-contacting, clamp-on type, which will provide benefits of non-fouling operation and easy installation.

The TDS-100 transit time flow meter utilizes two transducers that function as both ultrasonic transmitters and receivers. The transducers are clamped on the outside of a closed pipe at a specific distance from each other. The transducers can be mounted in V-method where the sound transverses the pipe twice, or W-method where the sound transverses the pipe four times, or in Z-method where the transducers are mounted on opposite sides of the pipe and the sound crosses the pipe once. This selection of the mounting method depends on pipe and liquid characteristics. The flow meter operates by alternately transmitting and receiving a frequency modulated burst of sound energy between the two transducers and measuring the transit time that it takes for sound to travel between the two transducers. The difference in the transit time measured is directly and exactly related to the velocity of the liquid in the pipe, as shown in Figure 1.

$$V = \frac{MD}{\sin 2\theta} \times \frac{\Delta T}{T_{up} \bullet T_{down}}$$



Where

θ is the include angle to the flow direction

M is the travel times of the ultrasonic beam

D is the pipe diameter

Tup is the time for the beam from upstream transducer to the downstream one

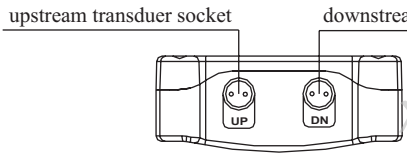
Tdown is the time for the beam from downstream transducer to the upstream one

ΔT=Tup –Tdown

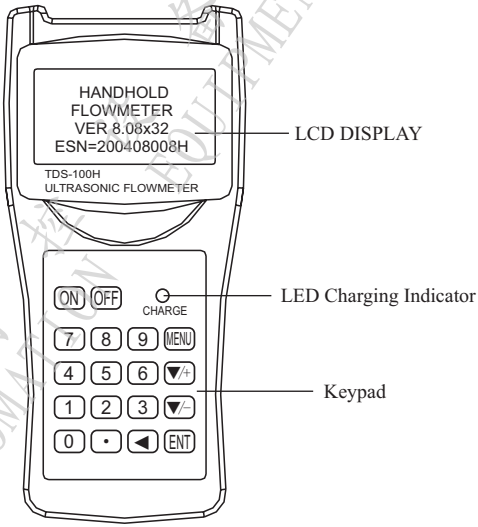
§1.4 Parts Identification

Converter:

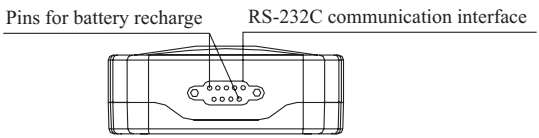
Top vierw



Front view

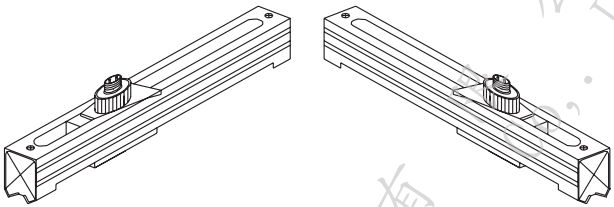


Bottom view

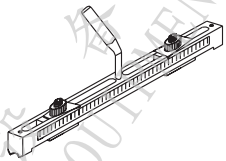


Transducers:

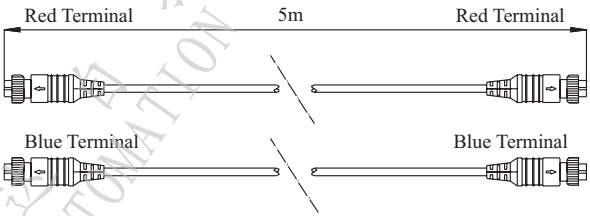
Standard-HM (50mm-700mm)



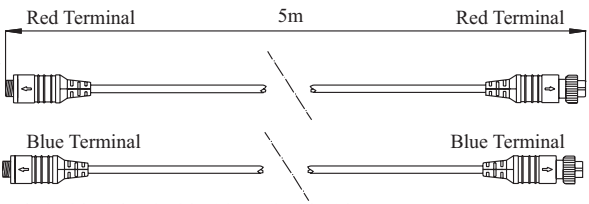
Standard-HS (20mm-100mm)
(Optional Accessaries)



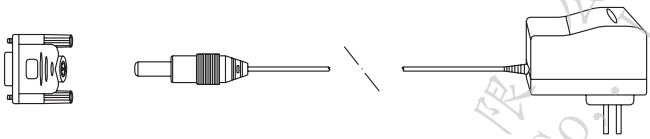
Cable 5m x2



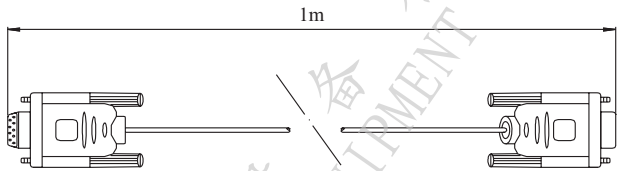
Extended Cable 5m x2(Optional Accessaries)



Converted Terminal and AC/DC Adapter



Cable of RS-232C interface



§1.5 Typical Applications

The TDS-100 flow meter can be virtually applied to a wide range of measurements. The measured pipe ranges 20-6000 mm [0.5 - 200 inch]. A variety of liquid applications can be accommodated: ultra-pure liquids, potable water, chemicals, raw sewage, reclaimed water, cooling water, river water, plant effluent, etc. Because the instrument and transducers are non-contacting and have no moving parts, the flow meter can not be affected by system pressure, fouling or wear. Standard transducers are rated to 110 ℃. Higher temperatures can be accommodated. For further information, please consult the manufacturer for assistance.

§1.6 Data Integrity and Built-in Time-Keeper

All user-inputted configuration values are retained in the built-in non-volatile flash memory that can store them for over 100 years, even if power is lost or turned off. Password protection is provided to avoid inadvertent configuration changes or totalizer resets.

A time-keeper is integrated in the flow meter for the index of date totalizing and works as the time base of flow accumulation. It keeps operating as long as the battery's terminal voltage is over 1.5V. In case of battery failure, the time-keeper will not keep running and it will lose proper time values. The user must re-enter proper time values in case the battery becomes totally exhausted. An improper time value affects no other functions but the date totalizer.

§1.7 Product Identification

Each set of the TDS-100 Series flow meter has a unique product identification or ESN written into the software that can only be modified with a special tool by the manufacturer. In case of any hardware failure, please provide this number which is located on menu window number M61 when contacting the manufacture.

§1.8 Specifications

Linearity	0.5%
Repeatability	0.2%
Accuracy	±1% of reading at rates>0.2 mps
Response Time	0-999 seconds, user-configurable
Velocity	±32 m/s
Pipe Size	20mm-6000mm
Rate Units	Meter, Feet, Cubic Meter, Liter, Cubic Feet, USA Gallon, Imperial Gallon, Oil Barrel, USA Liquid Barrel, Imperial Liquid Barrel, Million USA Gallons. User configurable.
Totalizer	7-digit totals for net, positive and negative flow respectively
Liquid Types	Virtually all liquids
Security	Setup values Modification Lockout. Access code needs unlocking
Display	4x8 Chinese characters or 4x16 English letters
Communication Interface	RS-232C, baud-rate: from 75 to 57600. Protocol made by the manufacturer and compatible with that of the FUJI ultrasonic flow meter. User protocols can be made on enquiry.
Transducers	Model M1 for standard, other 3 models for optional
Transducer Cord Length	Standard 2x10 meters, optional 2x 500 meters
Power Supply	3 AAA Ni-H built-in batteries. When fully recharged it will last over 10 hours of operation. 100V-240VAC for the charger
Data Logger	Built-in data logger can store over 2000 lines of data
Manual Totalizer	7-digit press-key-to-go totalizer for calibration
Housing Material	ABS
Case Size	100x66x20mm
Handset Weight	514g (1.2 lbs) with batteries

2. Starting Measurement

§2.1 Built-in Battery

The instrument can operate either from the built-in Ni-H rechargeable battery, which will last over 10 hours of continuous operation when fully recharged, or from an external AC/power supply from the battery charger.

The battery charging circuits employ a scheme of constant-current and constant-voltage. It has a characteristic of fast charging at the beginning and very slow charging when the battery approaches to full recharge. Generally, when the green LED starts coming on, the battery would be nearly 95% recharged and when the red LED is off, the battery would be 98% recharged.

Since the charging current becomes tapered when the battery recharge is nearly completed, i.e. the charging current becomes smaller and smaller, therefore, there should be no over-recharging problem. That means the charging progress can last very long. The charger can be connected to the handset all the time when an around-the-clock measurement is required.

When fully recharged, the terminal voltage reaches around 4.25V. The terminal voltage is displayed on window M07. When the battery is nearly consumed, the battery voltage drops to below 3V. The user can obtain an approximate battery working time from the battery voltage.
A software battery working time estimator is integrated in this instrument based on the terminal voltage. Please note that the estimator may have relatively bigger errors in the estimated working time, especially when the voltage is in the range of around 3.70 to -3.90 volt.

§2.2 Power On

Press the ON key to switch on the instrument and press the OFF to turn off the power.

Once the flow meter is switched on, it will run a self diagnostic program, checking first the hardware and then the software integrity. If there is any abnormality, corresponding error messages will display.

Generally, there should be no display of error messages, and the flow meter will go to the most commonly used Menu Window Number 01 (short for M01) to display the Velocity, Flow Rate, Positive Totalizer, Signal Strength and Signal Quality, based on the pipe parameters configured last time by the user or by the initial program.

The flow measurement program always operates in the background of the user interface. This means the flow measurement will keep on running regardless of any user menu window browsing or viewing. Only when the user enters new pipe parameters will the flow meter change measurement to the new parameter changes.

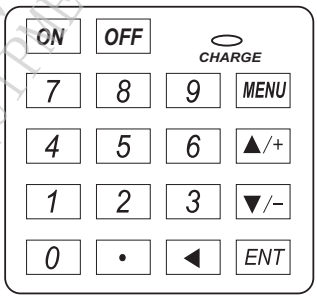
When new pipe parameters have been entered or when the power has been just switched on, the flow meter will enter an adjusting mode to make the signals magnified with proper amplification. By this step, the flow meter is going to find the best threshold of receiving signal. The user will see the progress by the number 1, 2, or 3, which are indicated on the right lower corner of the LCD display.

When the transducers have been adjusted on the pipe by the user, the flow meter will re-adjust the signal automatically.

Any user-entered configuration value will be retained into the NVRAM of the flow meter, until it is modified by the user.

§2.3 Keypad

The keypad for the operation of the flow meter has 16+2 keys, as shown by the right dia



Keys [0]~ [9] and [•] are keys to enter numbers

Key [▲/+] is the going UP key, when the user wants to go to the upper menu window. It also works as + key when entering numbers

Key [▼/-] is the going DOWN key, when the user wants to go down-sided menu window. It also works as the '–' key when entering numbers.

Key [◀] is backspace key, when the user wants go left or wants backspace the left character that is located to the left of the cursor.

Key [ENT] is the ENTER key for any inputting or selections.

Key [MENU] is the key for the direct menu window jump over. Whenever the user wants to proceed to a certain menu window, the user can press this key followed by 2-digit numbers.

The [MENU] key is shortened as the 'M' key afterward when referring to the menu windows.

The [ON] key is for the power on.
The [OFF] key is for the power off.

§2.4 Menu Windows

The user interface of this flow meter comprises about 100 different menu windows that are numbered by M00, M01, M02 … M99.

There are 2 methods to enter certain menu window:
(1) Direct going/entering. The user can press the [MENU] key followed by two-digit number keys. For example, the menu window M11 is for the entering of pipe outer diameter. The display will go to the M11 menu window after the user presses [MENU] [1] [1] .

(2) Pressing [▲/+] and [▼/-] keys. Each time of the [▲/+] key pressing will proceed to the lower-numbered menu window. For example, if the current window is on M12, the display will go to the number M11 window after pressing the [▲/+] key.
There are three different types of menu windows:
(1) Menu windows for number entering, like M11 for the entering of pipe outer diameter.
(2) Menu windows for option selection/selecting options, like M14 for the selection of pipe materials.
(3) Displaying windows only, like M00 to display Velocity, Flow Rate etc.

For number entering windows, the user can directly press the starting digit key when the user is going to modify the value. For example, when the current window is on M11, and the user is going to enter 219.2345 as the pipe outer diameter, the user can get the numbers entered by pressing the following serial keys: [2] [1] [9] [•] [2] [3] [4] [5] [ENT].

For the option selection windows, the user should first press the [ENT] key to a selection modification mode and then select the relevant options by pressing the [▲/+] and [▼/-] keys or the digit keys to select the option with a number antecedent to the option. In the end, the [ENT] key must be pressed to make the selection. For example, with menu window M14 for the selection of pipe material selection, (the [MENU] [1] [4] should be pressed first to enter this menu window if the current menu window is on a different window. The pipe material is stainless steel which has a number "1" antecedent to "stainless steel" on the display, the user should first press the [ENT] key to enter into a selection modification mode, then either make the selection by pressing the [▲/+] and [▼/-] keys to make the cursor on the line that displays "1. Stainless Steel", or make the selection by pressing the [1] key directly.

Generally, the [ENT] key must be pressed to enter a modification mode. If the "Locked M47 Open' message is indicated on the lowest line of the LCD display, it means the modification operations is locked out. In such cases, the user should go to M47 to have the instrument unlocked first before any further modification can be made.

§2.5 Menu Windows Arrangement

M00~M09 windows for the display of the flow rate, velocity, date time, totalizers, battery voltage and estimated working hours for the battery.
M10~M29 windows for entering the pipe parameter.
M30~M38 windows for flow rate unit selections and totalizer unit selections.
M40~M49 windows for response time, zeroing, calibration and modification password setup.
M50~M53 windows for the built-in logger
M60-M78 windows for time-keeper initialization, version and ESN information viewing and alarms.
M82 window for viewing date totalizer.
M90~M94 are diagnostic windows for a more accurate measurement.
M97~M99 are not windows but commands for the outputting of display copying and pipe parameter setups.
M+0~M+8 are windows for some additional functions, including a scientific calculator, viewer on records such as total working hours, turn-on and turn-off times, dates and times when the flow meter has been turned on or turned off.

Other menu windows such as M88 have no functions, or functions were cancelled because they are not applied to this version of the software.

The major reason why the menu windows are arranged in this way is that the software programmer hopes that the menu window arrangement for this version has the most/high ???? compatibility with the previous versions of the flow meter software. This will make it easier for the former version users with this flow meter series.

§2.6 Steps to Configure the Parameters

The following parameters need to be configured for a proper measurement:

(1) Pipe outer diameter
(2) Pipe wall thickness
(3) Pipe materials (for non-standard pipe materials*, the sound speed for the material must be configured too)
*Standard pipe materials and standard liquids refer to those with the sound parameters that have already been programmed into software of the flow meter, therefore there is no need to configure them
(4) Liner material and its sound speed and thickness, if there is any liner.
(5) Liquid type (for non-standard liquids, the sound speed of the liquid is also needed)
(6) Transducer type adapted to the flow meter. Generally the Standard M1 or the Frame M-sized transducers will be the selected option.
(7) Transducer mounting methods (the V-method or Z-method is the common option)
(8) Check up the Space displayed on M25 and install the transducers accordingly.

For standard pipe materials and standard liquids, the following detailed step-by-step setup is recommended.

(1) Press keys [MENU] [1] [1] to enter M11 window to input the digits for the pipe outer diameter, and then press [ENT] key.
(2) Press key [▼/-] to enter M12 window to input the digits for the pipe outer diameter and then press [ENT] key.
(3) Press key [▼/-] to enter M14 window, and press [ENT] key to enter the option selection mode. Use keys [▲/+] and [▼/-] to scroll up and down to the intended pipe material, and then press [ENT] key.
(4) Press key [▼/-] to enter M16 window, press [ENT] key to enter the option selection mode, use keys [▲/+] and [▼/-] to scroll up and down to the liner material, and then press [ENT] key. Select "No Liner", if there is no liner.
(5) Press key [▼/-] to enter M20 window, press [ENT] key to enter the option selection mode, use keys [▲/+] and [▼/-] to scroll up and down to the proper liquid, and then press [ENT] key.
(6) Press key [▼/-] to enter M23 window, press [ENT] key to enter the option selection mode, use keys [▲/+] and [▼/-] to scroll up and down to the proper transducer type, and then press [ENT] key.
(7) Press key [▼/-] to enter M24 window, press [ENT] key to enter the option selection mode, use keys [▲/+] and [▼/-] to scroll up and down to the proper transducer mounting method, and then press [ENT] key.
(8) Press key [▼/-] to enter M24 window to install the transducers on the pipe, and then press [ENT] key to go to M01 for the results.

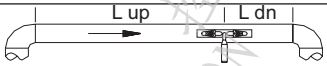
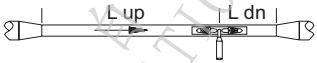
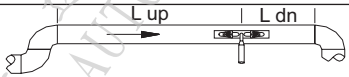
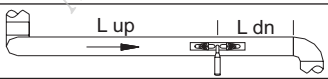
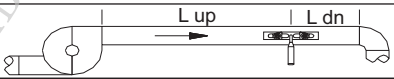
The first-time users may need some time to get familiar with the operation. However, the user friendly interface of the instrument makes the operation quite easy and simple. Before long, the user will configure the instrument with very little key pressing, since the interface allows the user to go to the desired operation directly without any extra steps.

The following tips will facilitate the operation of this instrument.
(1) When the window display is between M00 to M09, press a number key x , the user will go directly to the M0x window. For example, if the current window displays M01, press 7 and the user will go to M07.
(2) When the window display is under M00 to M09, press the ENT key and the user will go to M90; press ENT key to return. Press the dot key to go to M11
When the window display is under M25, press ENT key to go to M01.

§2.7 Transducers Mounting Allocation

The first step in the installation process is the selection of an optimum location in order to obtain a more accurate measurement. For this to be completed effectively, a basic knowledge about the piping and its plumbing system would be advisable.

An optimum location would be defined as a straight pipe length full of liquid that is to be measured. The piping can be in vertical or horizontal position. The following table shows

Piping Configuration and Transducer Position	Upstream Dimension L up x Diameters	Downstream Dimension L dn x Diameters
	10D	5D
	10D	5D
	10D	5D
	12D	5D
	20D	5D
	20D	5D
	30D	5D

examples of optimum locations.

Principles to selection of an optimum location

(1) Install the transducers on a longer length of the straight pipe. The longer the better, and make sure that the pipe is completely full of liquid.

(2) Make sure that the temperature on the location does not exceed the range for the transducers. Generally speaking, the closer to the room temperature, the better.

(3) Take the pipe fouling into consideration. Select a straight length of a relatively newer pipe. If the condition is not satisfying, consider the fouling thickness as part of the liner for a better result.

(4) Some pipes have a kind of plastic liner, and between the outer pipe and the liner there may be a certain thickness difference that will prevent the ultrasonic waves from direct traveling. Such conditions will make the measurement very difficult. Whenever possible, try to avoid this kind of pipes. If impossible, try our plug-in transducers that are installed permanently on the pipe by drilling holes on the pipe while liquid is running inside.

§2.8 Transducers Installation

The transducers used by the TDS-100 series ultrasonic flow meter are made of piezoelectric crystals both for transmitting and receiving ultrasonic signals through the wall of liquid piping system. The measurement is realized by measuring the traveling time difference of the ultrasonic signals. Since the difference is very small, the spacing and the alignment of the transducers are critical factors to the accuracy of the measurement and the performance of the system. Meticulous care should be taken for the installation of the transducers.

Steps to the installation of the transducers

(1) Locate an optimum position where the straight pipe length is sufficient, and where pipes are in a favorable condition, e.g., newer pipes with no rust and ease of operation.

(2) Clean any dust and rust. For a better result, polishing the pipe with a sander is strongly recommended.

(3) Apply adequate coupler to the spot where the transducers are to be installed and leave no gap between the pipe surface and the transducers.

Extra care should be taken to avoid any sand or dust particles left between the pipe outer surface and the transducers.

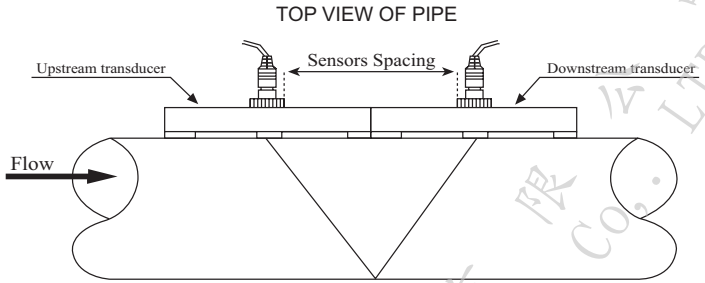
To avoid gas bubbles inside the upper part of the pipe, the transducers should be installed horizontally by the side of the pipe.

§2.8.1 Transducers Spacing

The spacing value shown on menu window M25 refers to the distance of inner spacing between the two transducers. The actual transducers spacing should be as close as possible to the spacing value.

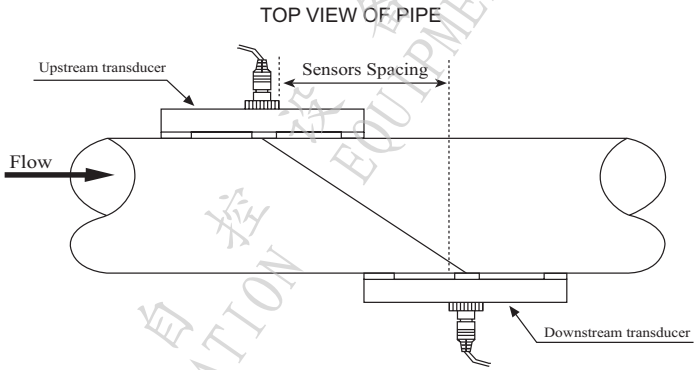
§2.8.2 V-method Installation

V-method installation is the moswidely used mode for daily measurement with pipe inner diameters ranging from 20 millimeter to 300 millimeter. It is also called reflective mode or method.



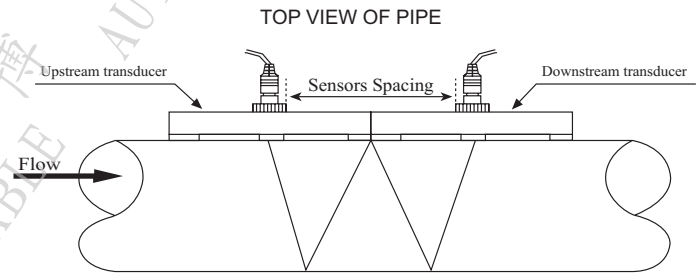
§2.8.3 Z-method Installation

Z-method is commonly used when the pipe diameter is between 300 millimeters and 500 millimeters.



§2.8.4 W-method Installation

W-method is usually used on plastic pipes with a diameter from 10 millimeters to 100 millimeters



§2.8.5 N-method Installation

Rarely used method.

§2.9 Installation Checkup

Through the checkup of the installation, one can: check the receiving signal strength, the signal quality Q value, the traveling time difference of the signals, the estimated liquid speed, the measured traveling time of the signals and the calculated traveling time ratio. Therefore, optimum measurement result and longer running time of the instrument can be achieved.

§2.9.1 Signal Strength

Signal strength indicates the amplitude of receiving ultrasonic signals by a 3-digit number. [000] means there is no signal detected, and [999] refers to the maximum signal strength that can be received.

Although the instrument works well if the signal strength ranges from 500 to 999, stronger signal strength should be pursued, because a stronger signal means a better result. The following methods are recommended to obtain stronger signals:

(1) Relocate a more favorable location, if the current location is not good enough for a stable and reliable flow reading, or if the signal strength is lower than 700.

(2) Try to polish the outer surface of the pipe, and apply more coupler to increase the signal strength.

(3) Adjust the transducers both vertically and horizontally while checking the varying signal strength, stop at the highest position, and then check the transducers spacing to make sure the transducers spacing is the same as what the M25 shows.

§2.9.2 Signal Quality

Signal quality is indicated as the Q value in the instrument. A higher Q value would mean a higher Signal and Noise Ratio (short for SNR), and accordingly a higher degree of accuracy would be achieved. Under normal pipe condition, the Q value is in the range 600-900, the higher the better. Causes for a lower Q value could be:

(1) Interference of other instruments and devices such as a powerful transverter working nearby. Try to relocate the flow meter to a new place where the interference can be reduced.

(2) Bad sonic coupling for the transducers with the pipe. Try to apply more coupler or clean the surface, etc.

(3) Pipes are difficult to be measured. Relocation is recommended.

§2.9.3 Total Transit Time and Delta Time

The numbers displayed on menu window M93 are called total transit time and delta time respectively. They are the primitive data for the instrument to calculate the flow rate inside the pipe. So the flow rate indication will vary accordingly with the total time and delta time.

The total transit time should remain stable or vary little.
If the delta time fluctuates higher than 20%, it means there are certain kinds of problems with the transducer installation.

§2.9.4 Time Ratio between the Measured Total Transit Time and the Calculated Time

This ratio would be used to check the transducer installation. If the pipe parameters are entered correctly and the transducers are installed properly, the value for this ratio should be in the range of 1003. If this range is exceeded, the user should check:
(1) If the pipe parameters are correctly entered.
(2) If the actual spacing of the transducers is right and the same as what the window M25 shows.
(3) If the transducers are installed properly in the right directions.
(4) If the mounting location is good and if the pipe has changed shape or if there is too much fouling inside the pipes
(5) Other poor conditions.

3. How To

§3.1 How to judge if the instrument works properly

When 'R' is displayed in the lowest right corner of LCD display, the instrument is working properly, generally speaking.

If an 'H' flashes on that place, there could be poor signal received. Please refer to the chapters on diagnosis.

If an 'I' is displayed, it means that there is no signal detected.

If a 'J' is displayed, it means that the hardware of this instrument could be out of order. Refer to the chapter on diagnosis.

§3.2 How to judge the liquid flowing direction

(1) Make sure that the instrument works properly
(2) Check the flow rate for the indication. If the displayed value is POSITIVE, the direction of the flow will be from the RED transducers to the BLUE transducers; if the displayed value is NEGATIVE, the direction will be from the BLUE transducers to the RED transducers;

§3.3 How to change between units systems

Use menu window M30 for the selection of unit system in English or Metric system.

§3.4 How to select a required flow rate unit

Use menu window M31 to select the flow unit first and then the timing unit.

§3.5 How to use the totalizer multiplier

Use window M33 to select a proper totalizer. Make sure that the totalizer pulse is appropriately speeded. It should not be too fast and neither too slow. A speed of producing a pulse in several seconds or minutes is preferable.

If the totalizer multiplier is too small, there can be a loss of accumulation pulse because the output device can output only one pulse in a measurement period (500milliseconds)

If the totalizer multiplier is too large, the output pulse will be too fewer for the devices that are connected with the instrument for a quicker response.

§3.6 How to open or shut the totalizers

Use M34, M35 and M36 to turn on or turn off the POS, NEG, or NET totalizer respectively.

§3.7 How to reset the totalizers

Use M37 to reset the proper totalizer.

§3.8 How to restore the flow meter with default setups

Use M37, when the 'selection' message is displayed. Press the dot key first and the message 'Master Erase' will display, then press the backspace key ◀

The master erase step will erase all the parameters entered by the user and setup the instrument with default values.

§3.9 How to use the damper

The damper acts as a filter for a stable reading. If '0' is entered in window M40, that means there is no damping. A bigger number brings a more stable effect. But bigger damper numbers will prevent the instrument from acting quickly.

Numbers 0 to 10 are commonly used for the damper value.

§3.10 How to use the zero-cutoff function

The number displayed in window M41 is called the low-cutoff value. The flow meter will replace these flow rate values that are absolutely less than the low-cutoff value with '0'. This means the flow meter will avoid any invalid accumulation when the actual flow is below the zero-cutoff value.

The low-cutoff value does not affect the flow measurement when the actual flow is absolutely greater than the low-cutoff value.

§3.11 How to setup a zero point

There exists a 'Zero Point' with certain installation which means the flow meter will display a non-zero value when the flow is absolutely stopped. In this case, setting a zero point with the function in window M42 will bring a more accurate measurement result.

Make sure that the flow is absolutely stopped, then run the function in window M42 by pressing the ENT key.

§3.12 How to get a scale factor for calibration

A scale factor is the ratio between the 'actual flow rate' and the indicated value by the flow meter. The scale factor can be determined by calibration with flow calibration equipment.

§3.13 How to use the operation locker

The system locker provides a means of preventing inadvertent configuration changes or totalizer resets.

When the system is locked, menu window browsing can be done without affecting any change, but any modifications are prohibited.

The system can be locked without a password or with a one 1 to 4 digit password. With a no-password locking, directly press the ENT key when the password input prompt displays.

If the password is forgotten, please contact the factory.

§3.14 How to use the built-in data logger

The data logger has a space of 24K bytes of memory, which will hold about 2000 lines of data. Use M50 to turn on the logger and for the selection for the items that is going to be logged. Use M51 for the times when the logging begins and at how long an interval sustains and how long the data logging will last.

Use M52 for the direction of logging data. The default setting will permit the logging data to be stored in the logger buffer.

Logging data can be redirected to the RS-232C interface without being stored into the logger buffer.

Use M53 to view the data in the logger buffer.

Dumping the logging data through the RS-232C interface and the clearing of the buffer can be operated with a function in window M52.

§3.15 How to use the Frequency Output

There is a Frequency Output in all TDS-100 series flow meters. This frequency output signal, which represents the flow rate, is intended to connect with other instruments.

The Frequency Output is totally user-configurable. Generally, four parameters should be configured for the setups.

Enter the lower flow rate value in window M68 and the higher flow rate value in window M69.

Enter the frequency range in window M67.

For example, assume that the flow rate varies in a range 0m3/h to 3000m3/h, and an output signal is at a maximum frequency of 1000Hz, the minimum of 200Hz is going to be required for other instrumentation. The user should enter 0 in M68 and 3000 in M69, and enter 200 and 1000 in window M67.

Please note that the user has to make the selection with OCT setups in window M78 by selecting the 13th option reading like 'FO output' to direct the frequency output to the OCT OUTPUT hardware device.

§3.16 How to use the Totalizer Pulse Output

The totalizer output will produce a pulse output with every unit flow of the totalizer.

Refer §3.4 and §3.5 for the setups of the totalizer units and multiplier.

The totalizer pulse output can only be realized by mapping the pulse output to the OCT or BUZZER hardware devices.

For example, assume that the POS totalizer pulse output is needed, and every pulse should represent 0.1cubic meter of liquid flow; the pulse output will be mapped to the internal Buzzer, so that with every 0.1 cubic meter of flow the BUZZER will beep for a while.

The following setups should be taken/performed:
(1) Select the unit Cubic Meter under window M32.
(2) Select the Multiplier as '2. X0.1' under window M33.
(3)Select the output option '9. POS INT Pulse' under window M77. (INT stands for totalized)

§3.17 How to produce an alarm signal

There are 2 types of hardware alarm signals that are available with this instrument. One is the Buzzer, and the other is the OCT output.

Both for the Buzzer and OCT output the triggering sources of the event include the following:
(1) Alarms on when there is no receiving signal
(2) Alarms on when there is poor signal received.
(3) Alarms on when the flow meter is not in normal measurement modes.
(4) Alarms on reverse flow.
(5) Alarms on the overflow of the Frequency Output
(6) Alarms on when the flow is out of a designated range set by the user.

There are two out-of-normal-range alarms in this instrument. They are called #1 Alarm and #2 Alarm. The flow range can be user-configurable through M73, M74, M75, M76.

For example, assume that the Buzzer should start beeping when the flow rate is less than 300 m3/h and greater than 2000m3/h, the following steps for setups would be recommended.
(1) Enter 300 under M73 for #1 alarm low flow rate
(2) Enter 2000 under M74 for #1 alarm high flow rate
(3) Select the item reading like '6. Alarm #1' under M77.

§3.18 How to use the built-in Buzzer

The built-in buzzer is user-configurable. It can be used as an alarm. Use M77 for setups.

§3.19 How to use the OCT output

The OCT output is user-configurable, which can be performed by selecting the proper input source such as pulse output.
Use M78 for the setups.
Please make sure that the Frequency Output shares the OCT.

The OCT output shares pins with the RS-232C interface, and the terminal is at Pin 6 and the ground is at Pin 6.

§3.20 How to modify the built-in calendar

No modification on the built-in calendar will be needed in most cases. The calendar runs on insignificant amount of power supply. Modification will be required only in such cases as when the battery is totally consumed, or when the changing of the battery takes a long time.

Press the ENT key under M61 for Modification. Use the dot key to skip over these digits that need no modification.

§3.21 How to adjust the LCD contrast

Use M70 to the LCD contrast. The adjusted result will be stored in the EEPROM so that the MASTER ERASE will make no effect on the contrast.

§3.22 How to use the RS232 serial interface

Use M62 for the setup of the RS-232C serial interface.

§3.23 How to view the Date Totalizers

Use M82 to view the date totalizers that are comprised of a daily totalizer, a monthly totalizer and a yearly totalizer.

§3.24 How to use the Working Timer

Use the working timer to check the time that has passed with a certain kind of operation. For example, use it as a timer to show how long a fully-charged battery will last.

Under M72, press ENT key and then select YES to reset the timer.

§3.25 How to use the manual totalizer

Use M28 for the manual totalizer. Press ENT key to start and stop the totalizer.

§3.26 How to check the ESN and other minor details

Every set of the TDS-100 series flow meter utilizes a unique ESN to identify the meter. The ESN is an 8-digit number that provides the information of version and manufacturing date.

The user can also employ the ESN for instrumentation management.

The ESN is displayed in window M61.

Other details about the instrument are the total working hours displayed in window M+1, and the total power-on times displayed in window M+4.

§3.27 How to know how long the battery will last

Use M07 to check how long the battery will last. Also please refer to §.2.1

§3.28 How to charge the built-in battery

Refer to §2.1

4. Menu Window Details

Menu window No.	Function
M00	Display three positive negative net totalizers, signal strength, signal quality and working status
M01	Display POS totalizer, flow rate, velocity, signal strength, signal quality and working status
M02	Display NEG totalizer, flow rate, velocity, signal strength, signal quality and working status
M03	Display NET totalizer, flow rate, velocity, signal strength, signal quality and working status
M04	Display date and time, flow rate, signal strength, signal quality and working status
M05	Display date and time, velocity, signal strength, signal quality and working status
M06	Display the wave shape of the receiving signal
M07	Display the battery terminal voltage and its estimated lasting time
M08	Display the all the detailed working status, signal strength, signal quality
M09	Display today's total flow, velocity, signal strength, signal quality and working status
M10	Window for entering the outer perimeter of the pipe
M11	Window for entering the outer diameter of the pipe 0 to 6000mm is the allowed range of the value.
M12	Window for entering pipe wall thickness
M13	Window for entering the inner diameter of the pipe
M14	Window for selecting pipe material Standard pipe materials (that the user need not know the speed) include: (0) carbon steel (1) stainless steel (2) cast iron (3) ductile iron (4) copper (5) PVC (6) aluminum (7) asbestos (8) fiberglass
M15	Window for entering the pipe material speed only for non-standard pipe materials
M16	Window for selecting the liner material, select none for pipes without any liner Standard liner materials that the user need not know the speed include: (1) Tar Epoxy (2) Rubber (3) Mortar (4) Polypropylene (5) Polystryol (6)Polystyrene (7) Polyester (8) Polyethylene (9) Ebonite (10) Teflon
M17	Window for entering the liner material speed only for non-standard liner materials
M18	Window for entering the liner thickness, if there is a liner
M19	Window for entering the ABS thickness of the inside wall of the pipe
M20	Window for selecting fluid type For standard liquids that the user need not know the liquid speed include: (0) Water (1) Sea Water (2) Kerosene (3) Gasoline (4) Fuel oil (5) Crude Oil (6) Propane at -45C (7) Butane at 0C (8)Other liquids (9) Diesel Oil (10)Caster Oil (11)Peanut Oil (12) #90 Gasoline (13) #93 Gasoline (14) Alcohol (15) Hot water at 125C

M21	Window for entering the fluid sonic velocity only for non-standard liquids
M22	Window for entering the viscosity of the non-standard liquids
M23	Window for selecting the proper transducers There are 14 different types of transducers for selection. If the user-type-transducers are used, 4 user type wedge parameters, which will be prompted by the software, should be entered following. If the π type transducers are used, 3 π type transducers and pipe parameters should be entered following.
M24	Window for selecting the transducer mounting methods Four methods can be selected: (0) V-method (1) Z-method (2) N-method (3) W-method
M25	Display the transducer mounting spacing
M26	Entry to store the parameter configuration into the internal NVRAM
M27	Entry to load one set of saved parameters
M28	Select YES or NO for the instrument to determine whether or not to hold (or to keep) the last correct value when poor signal condition occurs. YES is the default setup
M29	Enter a value ranging from 000 to 999. 0 is the default value
M30	Window for selecting unit system. Default value is 'Metric'. The change from English to Metric or vice versa will not affect the unit for totalizers.
M31	Window for selecting flow rate that will be used by the instrument afterward. Flow rate can be in 0. Cubic meter short for (m3) 1. Liter (l) 2. USA gallon (gal) 3. Imperial Gallon (igl) 4. Million USA gallon (mgl) 5. Cubic feet (cf) 6. USA liquid barrel (bal) 7. Imperial liquid barrel (ib) 8. Oil barrel (ob) The flow unit in terms of time can be per day, per hour, per minute or per second. So there are 36 different flow rate units in total for selection.
M32	Window for selecting the totaliziers' working unit
M33	Select totalizer multiplier The multiplier ranges from 0.001 to 10000
M34	Turn on or turn off the NET totalizer
M35	Turn on or turn off the POS totalizer
M36	Turn on or turn off the NEG totalizer
M37	(1) Totalizer reset (2) Restore the instrument to the default parameters as the manufacturer did

	by pressing the dot key followed by the backspace key. Take care or make note on the parameters before doing the restoration
M38	Press-a-key-to-run or to stop totalizer for easier calibration
M39	Operational interface language selection in Chinese and English. This selection makes it possible that more than 2 billions of people on the world can read the menu.
M40	Flow rate damper for a stable value. The input range is 0 to 999 seconds. 0 means there is no damping. Default value is 10 seconds
M41	Lower flow rate cut-off to avoid invalid accumulation.
M42	Zero point setup under the condition when there is no liquid running inside the pipe.
M43	Clear the zero point set by the user, and restore the zero point set by the manufacturer
M44	Set up a manual flow bias. Generally this value should be 0.
M45	Scale factor for the instrument. The default value is '1'. Keep this value as '1', when no user calibration has been made.
M46	Network environment Identification Number. Any integer can be entered except 13(0DH, carriage return), 10 (0AH, line feeding), 42 (2AH), 38, 65535. Every set of the instrument in a network environment should have a unique IDN. Please refer to the chapter for communication.
M47	System locker to avoid modification of the parameters
M48	Not used
M49	Communication tester
M50	"Option" selection for the built-in logger. It also functions as the switch of logger
M51	Time setup for the data logger
M52	(1) Data logging direction control. If 'To RS-232' is selected, all the data produced by the data logger will be transmitted out through the RS-232 interface (2) If 'To buffer ' is selected, the data will be stored into the built-in logger memory (3) Buffer transferring and buffer clearing
M53	Logger buffer viewer. It functions as a file editor. Use Dot, backspace UP and DN keys to browse the buffer. If the logger is ON, the viewer will automatically refresh once new data are stored
M54	Not used
M55	Nod used
M56	Not used
M57	Not used
M58	Not used
M59	Not used
M60	99-year calendar. Press ENT for modification. Use the dot key to skip the digits that need no adjusting.

M61	Display Version information and Electronic Serial Number (ESN) that are unique for each TDS-100 series flow meter. The users can employ the ESN for instrumentation management
M62	RS-232 setup. Baud rate can be 75 to 115200 bps
M63	Not used
M64	Not used
M65	Not used
M66	Not used
M67	Input the frequency range for the frequency output. The biggest range is 0Hz-9999Hz. Default value is 1-1001 Hz
M68	Enter a flow rate value that corresponds to lower frequency
M69	Enter a flow Rate value that corresponds to higher frequency
M70	LCD display backlight control. The entered value indicates how many seconds the backlight will be on with every key pressing.
M71	LCD contrast control. The LCD will become darker when a small value is entered.
M72	Working timer. It can be cleared by pressing ENT key, and then select YES.
M73	Enter Lower Flow Rate value that will trigger the #1 Alarm. There are two virtual alarms in the system. By “virtual” we mean that the user must redirect the output of the alarms by setuping the output hardware in M78 and M77
M74	Enter the higher flow rate value that will trigger the #1 Alarm.
M75	Enter the lower flow rate value that will trigger the #2 Alarm.
M76	Enter the higher flow rate value that will trigger the #2 Alarm.
M77	Buzzer setup. If a proper input source is selected, the buzzer will beep when the trigger event occurs
M78	OCT (Open Collect Transistor Output) setup By selecting a proper input source, the OCT hardware will close when the trigger event occurs
M79	Not used
M80	Work as a keypad and display for another handhold set by RS-232 connected with the handset
M81	Not used
M82	Date totalizer
M83	Not used
M84	Not used
M85	Not used
M86	Not used

M87	Not used
M88	Not used
M89	Not used
M90	Display signal strength, signal quality, time ratio on the upper right corner.
M91	Displays the Time Ratio between the Measured Total Transit Time and the Calculated time. If the pipe parameters are entered correctly and the transducers are properly installed, the ratio value should be in the range of 100± 3%. Otherwise the entered parameters and the transducer installation should be checked.
M92	Displays the estimated fluid sound velocity. If this value has an obvious difference with the actual fluid sound speed, pipe parameters entered and the transducer installation should be checked again.
M93	Displays total transit time and delta time(transit time difference)
M94	Displays the Reynolds number and the pipe factor used by the flow rate program.
M95	Not used
M96	Not used
M97	Command to record the pipe parameters entered by the user either to the built-in data logger or to RS-232C serial interface
M98	Command to record the diagnostic information either to the built-in data logger or to RS-232C serial interface
M99	Command to copy the current display either to the built-in data logger or to RS-232C serial interface
M+0	Browse the 64 recorded instrument power-on and power-off date and time with the flow rate at the time of power on and off
M+1	Displays the total working time of the instrument
M+2	Displays the last power-off date and time
M+3	Displays the last power-off flow rate
M+4	Displays the times of instrument powered on(the instrument has been powered on)
M+5	A scientific calculator for the convenience of field working. All the values are in single accuracy. The drawback is that the user can't operate it by direct key-pressing
M+6	Not used
M+7	Not used
M+8	Not used
M+9	Not used
M-0	Entry to hardware adjusting windows only for the manufacturer

5.Troubleshooting

§5.1 Power-on Error Displays and Counter-Measures

The TDS-100 series ultrasonic flow meter provides an automatic power-on diagnosis for the hardware problems. When any message (with the power on) in the following table displays, counter-measures should be taken.

Error message	causes	Counter-measures
ROM Testing Error Segment Test Error	Problem with the software	(1)Power on again (2)Contact with factory
Stored Data Error	The parameters entered by the user lose integration.	When this message displays, the user should press ENT key, and all the configuration will be restored to the default state.
Timer Slow Error Timer Fast Error	Problem with the timer-keeper or the crystal oscillator.	(1)Power on again (2)Contact with factory
Date Time Error	Number errors with the calendar	Initialize the calendar by menu window M61
Reboot repetitively	Hardware problems	Contact the factory

§5.2 Error Code and Counter-Measures

The TDS-100 series ultrasonic flow meter will show Error Code in the lower right corner with a single letter like I, R etc. on menu windows M00, M01, M02, M03, M90 and M08. When any abnormal Error Code shows, counter-measures should be taken.

Error code	Correspondent Message displayed on M08	Causes	Counter-measures
R	System Normal	No error	
I	Detect No Signal	(1)No Signals detected (2)Transducers installed improperly (3)Too much fouling (4)Pipe liners are too thick. (5)Transducer cords are not properly connected	(1)Relocate measuring location (2)Clean the spot (3)Check the cords
J	Hardware Error	Hardware problem	Contact the factory
H	PoorSig Detected	(1)Poor signal detected (2)Transducers installed improperly (3)Too much fouling (4)The pipe liners are too thick. (5)Problem with transducers cords	(1)Relocate measuring place (2)Clean the spot (3)Check the cords (4)Check the coupler

Q	Frequ OutputOver	The actual frequency for the Frequency Output is out of the range set by the user	Check the value entered at M66, M67,M68 and M69, and try to enter a larger value on M69
F	System RAM Error Date Time Error CPU or IRQ Error ROM Parity Error	(1) Temporary problems with RAM, RTC (2) Permanent problems with hardware	(1) power on again (2) contact factory
1 2 3	Adjusting Gain	Instrument is in the progress of adjusting the gain for the signal, and the number indicates the progressive steps	
K	Empty pipe	(1) No liquid inside pipe (2) Setup error on M29	(1) Relocate where the pipe is full of liquid (2) Enter 0 on M29

§5.3 Other Problems and Solutions

(1) When the actual flow inside the pipe is not standstill, but the instrument displays 0.0000 for the flow rate, and 'R' displaying signal strength and the signal quality Q (value) has a satisfactory value?

The problems are likely caused by the user who has used the 'Set Zero' function on this non-standstill flowing pipe. To solve this problem, use the 'Reset Zero' function on menu window M43.

(2) The displayed flow rate is much lower or much higher than the actual flow rate in the pipe under normal working conditions.

(a) There is probably an offset value wrongly entered by the user in M44. Enter '0' in M44.

(b) Problem with transducer installation.

(c) There is a 'Zero Point'. Try to 'zero' the instrument by using M42 and make sure that the flow inside the pipe should be standstill.

(3) The battery can not work as long as the time period as indicated by M07

(a) Battery should be replaced due to the end of the service life.

(b) Newly changed battery does not fit the battery estimating software. Customizing the battery with the software should be taken. Please contact the factory.

(c) The battery has not been fully recharged or the recharge has been stopped too many times halfway.

(d) There is indeed a time difference between the actual working time and the estimated one, especially when the terminal voltage is in the range 3.70 and 3.90 volt. Please refer to battery voltage for a closer estimated working time.

6. Communication Protocol

§6. 0 General

The TDS-100 series ultrasonic flow meter integrates a standard RS-232C communication interface and a complete set of communication protocols that are compatible with that of the Fuji's ultrasonic flow meter.

§6.1 Interface Pin-out Definition

Pin		
	1	for battery recharge, positive input
	2	RXD
	3	TXD
	4	not used
	5	GND
	6	OCT output
	7	not used
	8	for battery recharge, negative input
	9	RING input for connecting a MODEM

§6.2 the Protocol

The protocol is comprised of a set of basic commands that is a string in ASCII format, ending with a carriage (CR) and line feed (LF). Commonly used commands are listed in the following table.

Command	Function	Data Format
DQD(CR)	Return flow rate per day	± d.dddddd E± dd(CR)（LF）*
DQH(CR)	Return flow rate per hour	± d.dddddd E± dd(CR)（LF）
DQM(CR)	Return flow rate per minute	± d.dddddd E± dd(CR)（LF）
DQS(CR)	Return flow rate per second	± d.dddddd E± dd(CR)（LF）
DV(CR)	Return flow velocity	± d.dddddd E± dd(CR)（LF）
DI+(CR)	Return POS totalizer	± ddddddd E± d(CR)（LF）**
DI-(CR)	Return NEG totalizer	± ddddddd E± d(CR)（LF）
DIN(CR)	Return NET totalizer	± ddddddd E± d(CR)（LF）
DID(CR)	Return Identification Number	ddddd (CR) (LF)
DL(CR)	Return signal strength and quality	S=ddd,ddd Q=dd (CR) (LF)
DT(CR)	Return date and time	yy-mm-dd hh:mm:ss(CR) (LF)
M@(CR)***	Send a key value as if a key is pressed	
LCD(CR)	Return the current window display	

FOdddd(CR)	Force the FO output with a frequency in dddd Hz	
ESN(CR)	Return the ESN for the instrument	Ddddddd(CR)(LF)
RING(CR)	Handshaking Request by a MODEM	
OK(CR)	Response from a MODEM	No action
GA	Command for GSM messaging	Please contact factory for detail
GB	Command for GSM messaging	
GC	Command for GSM messaging	
DUMP(CR)	Return the buffer content	In ASCII string format
DUMP0(CR)	Clear the whole buffer	In ASCII string format
DUMP1(CR)	Return the whole buffer content	In ASCII string Format, 24KB in length
W	Prefix before an Identification Number in a network environment. The IDN is a word, ranging 0-65534.	
N	Prefix before an Identification Number in a network environment. The IDN is a single byte value, ranging 00-255.	
P	Prefix before any command	
&	Command connector to make a longer command by combining up to 6 commands	

Notes * CR stands for Carriage Return and LF for Line Feed.
** ‘d’ stands for the 0~9 digit numbers.
*** @ stands for the key value, e.g., 30H for the ‘0’ key.

§6.3 Protocol Prefix Usage

(1) Prefix P

The prefix P can be added before any command in the above table to have the returning data followed with two bytes of CRC check sum, which is the adding sum of the original character string.

Take the DI+(CR) command as an example. Assume that DI+(CR) would return +1234567E+0m3 (CR)(LF)(the string in hexadecimal is 2BH, 31H, 32H, 33H, 34H, 35H, 36H, 37H, 45H, 2BH, 30H, 6DH, 33H, 20H, 0DH, 0AH) , then PDI(CR) would return +1234567E+0m3!F7(CR)(LF). ‘!’ acts as the starter of check sum which is yielded by adding up the string 2BH, 31H, 32H, 33H, 34H, 35H, 36H, 37H, 45H, 2BH, 30H, 6DH, 33H, 20H.

Please note that there will be SPACES (20H) before ‘!’.

(2) Prefix W

The prefix W should be used in the network environment. The usage format is W + digit string which stands for the IDN + basic command.
The digit string should have a value between 0 and 65534 except 13(0DH), 10 (0AH), 42(2AH,*), 38(26H, &).
For example, if the IDN=12345 instrument is addressed and returning the velocity of that instrument is requested, the command will be W12345DV(CR).

(3) Prefix N

The prefix N is a single byte IDN network prefix, not recommended in a new design. It is reserved only for the purpose of the compatibility with the former versions

(4) Command Connector &

The & command connector can connect up to 6 basic commands to form a longer command so that it will make the programming much easier.
For example, assume that the measurement of an instrument with IDN=4321 are going to be returned, and (then) all the following 3 values--- (1) flow rate (2) velocity (3)POS totalizer---will be returned simultaneously. The combined command would be W4321DQD&DV&DI+(CR), and the result would be:
+1.234567E+12m3/d(CR)
+3.1235926E+00m/s(CR)
+1234567E+0m3(CR)

§6.4 Codes for the Keypad

The codes for the keypad should be used when the instrument is connected with other terminals that operate the instrument by transmitting the 'M' command along with the keypad code. By this function, remote operation of this instrument can be realized, even via the Internet.

Key	Hexadecimal Key code	Decimal Key code	ASCII Code
0	30H	48	0
1	31H	49	1
2	32H	50	2
3	33H	51	3
4	34H	52	4
5	35H	53	5
6	36H	54	6
7	37H	55	7

Key	Hexadecimal Key code	Decimal Key code	ASCII Code
8	38H	56	8
9	39H	57	9
•	3AH	58	:
◀	3BH,0BH	59	;
MENU	3CH,0CH	60	<
NET	3DH,0DH	61	=
▲/+	3EH	62	>
▼/−	3FH	63	?

7. Warranty and Service

§7.1 Warranty

The manufacturer provides one year warranty on all products, free of charge, but the users should be responsible for the one-way transportation fee from the customer to the factory.

§7.2 Service

The manufacturer provides instrument installation for our customers, and the charges will be made according the cost.

For any hardware failure of the instrument, we recommend that our customers send back the instrument to our factory for service, due to the fact that the instrument is made of microprocessors and it will be difficult to perform field maintenance. Before sending back the instrument, please try to contact the factory first to make sure what the problem is.

For other operational problems, please contact our service department by telephone, fax or email and internet. In most cases, the problem could be solved immediately.

§7.3 Software Upgrade Service

We provide free-of-charge software upgrade services. Please contact the factory for any lately developed software.

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