Hardware
Documentation

Data Sheet

HAL® 83x

强大的多用途可编程
线性霍尔效应传感器系列

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内容

强大的多用途可编程线性霍尔效应传感器系列

发行说明：修订栏表示对以前版本进行重大更改。

1. 介绍

HAL83x 是 Micronas 系列可编程线性霍尔传感器的新成员。 这个强大的多用途系列可以取代 HAL 805，HAL 815，HAL 825 和 HAL810。 与第一代设备相比，它提供更好的质量，扩展功能和性能。 这个新家族由两个成员组成：HAL830 和 HAL835。 与 HAL830 相比，HAL835 是具有完整功能和最大性能的设备。

HAL83x 是基于霍尔效应的通用磁场传感器，具有线性输出。 当与旋转或移动的磁铁结合使用时，IC 可用于角度或距离测量。 磁场范围，灵敏度，输出静态电压（B = 0 mT 时的输出电压）和输出电压范围等主要特性可在非易失性存储器中编程。 传感器具有比例输出特性，这意味着输出电压与磁通量和电源电压成正比。 可以编程连接到同一电源和地线的多个设备。

HAL83x 具有带自旋电流偏移补偿的温度补偿霍尔板，A / D 转换器，数字信号处理，带输出驱动器的 D / A 转换器，具有冗余和校准数据锁定功能的 EEPROM 存储器， 用于客户序列号的 EEPROM，用于编程 EEPROM 的串行接口以及所有引脚上的保护设备。

HAL83x 可通过调制电源电压进行编程。 不需要额外的编程引脚。 简单的可编程性允许通过直接调整输入电压到输入信号（如机械角度，距离或电流）来进行 2 点校准。 可以在客户的制造过程中对每个传感器进行个人调整。 使用此校准程序，传感器，磁铁和机械定位的公差可以在最终装配中得到补偿。

此外，通过编程霍尔传感器灵敏度的一阶和二阶温度系数，霍尔 IC 的温度补偿可以适应普通磁性材料。 这样可以在整个温度范围内以高精度进行操作。

单个传感器特性的计算和 EEPROM 存储器的编程可以通过 PC 和 Micronas 的应用套件轻松完成。

该传感器专为恶劣的工业和汽车应用而设计，可在-40°C 至 160°C 的环境温度范围内以 5 V 电源电压工作。 HAL83x 采用非常小的含铅封装 TO92UT-2，并且符合 AECQ 100 标准。

1.1. 应用

由于传感器的多功能编程特性和低温漂，HAL 83x 是最适合应用的最佳系统解决方案，例如：

– 踏板，涡轮增压器，节气门和 EGR 系统

– 距离测量

1.2. 一般特征

– 高精度线性霍尔效应传感器系列，具有 12 位比例模拟输出和数字信号处理功能

– 具有冗余和锁定功能的非易失性存储器（EEPROM）中的多个可编程磁性特性

– 从 TJ = -40°C 到 170°C 运行

– 在 4.5 V 至 5.5 V 的电源电压范围内工作，功能高达 8.5 V

– 以静态磁场和高达 2 kHz 的动态磁场运行

– p 可编程磁场范围从 ±30 mT 到 ±150 mT

– 带有 5kΩ上拉和下拉电阻的开路（接地和电源线断路检测），过压和欠压检测

– 为了将几个传感器内的单个传感器编程为与同一电源电压并联，可以通过输出引脚进行选择

– 温度特性可编程以匹配普通的磁性材料

– 可编程钳位功能

– 通过调制电源电压进行编程

– 所有引脚都具有过压和反向电压保护功能

– 磁特性对机械应力非常有效

– 短路保护推挽输出

– EMC 和 ESD 优化设计

1.2.1. HAL835 的器件特定功能

– 非常低的偏移量和灵敏度随温度变化

– 具有 11 位分辨率和 8 ms 周期的可选 PWM 输出

– 14 位多路复用模拟输出

– ±15 mT 的磁场范围

2. 订购信息

Micronas 器件有多种供货形式。 它们通过特定的订购代码进行区分：

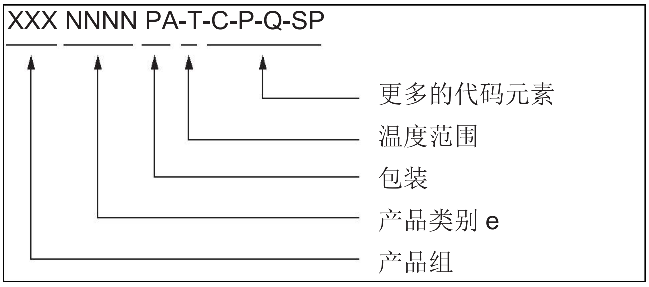


Fig. 2–1: 订购代码原则

有关详细信息，请参阅手册：“霍尔传感器：订购代码，包装，处理”。

2.1. 设备特定的订购代码

HAL 83x 有以下封装和温度变量。

Table 2–1: 可用包装

打包代码（PA）	包装类型
UT	TO92UT-1/2

Table 2–2:可用温度范围

温度代码（T）	温度范围
A	TJ = –40 °C 至 +170 °C

环境温度（TA）和结温（TJ）之间的关系在 5.4 节中解释。 第 28 页。

有关配置（C），包装（P），数量（Q）和特殊程序（SP）的可用变型，请联系 Micronas。

Table 2–3: 可用的订购代码和相应的包装标志

可用订购代码	包装标志
HAL830UT-A-[C-P-Q-SP]	830A
HAL835UT-A-[C-P-Q-SP]	835A

3. 功能说明

3.1. 一般功能

HAL83x 是可编程的线性霍尔效应传感器，只要选择模拟输出模式，该传感器就可以提供与通过霍尔板的磁通量成比例的输出信号，并与电源电压成正比（比率行为）。 当选择 PWM 输出模式时，PWM 信号与电源电压不成比例（仅适用于 HAL 835）。

垂直于封装品牌一侧的外部磁场分量会产生霍尔电压。 霍尔 IC 对磁性北极和南极敏感。 该电压被转换为数字值，并根据 EEPROM 寄存器的设置在数字信号处理单元（DSP）中进行处理并转换为输出信号。 第 3.2 节介绍了 DSP 的功能和参数。 第 8 页。

LOCK 寄存器的设置将禁止所有时间对 EEPROM 存储器的编程。 它也会破坏内存的读取。 该寄存器不能被重置。

只要 LOCK 寄存器没有置位，输出特性可以通过编程 EEPROM 寄存器来调整。 通过调节电源电压来解决 IC 问题（参见图 3-1）。 在 4.5 V 至 5.5 V 的电源电压范围内，传感器产生正常的输出信号。 检测到命令后，传感器读取或写入存储器，并在输出引脚上接收数字信号（另请参见应用笔记“HAL 8xy，HAL 100x 编程器板”）。 通讯期间输出关闭。 与同一电源和地线并联的多个传感器可以单独编程。 每个传感器的选择都通过其输出引脚完成。

对于 HAL835，用于生成 BiPhase-M 编程协议的数字输出也用于生成 PWM 输出信号。

如果 VSUP 或 GND 线损坏，开路检测功能可为模拟输出提供定义的输出电压。 内部温度补偿电路和自旋电流偏移补偿功能可以在整个温度范围内进行操作，同时精度和偏移稳定性的变化很小。 该电路还减少了由于封装机械应力而产生的偏移。 非易失性存储器由冗余和非冗余 EEPROM 单元组成。 非冗余 EEPROM 单元仅用于在传感器内部存储生产信息。 此外，传感器 IC 还配备有用于所有引脚的过压和反向电压保护的器件。

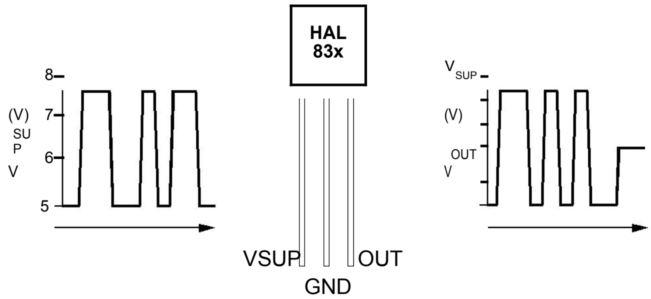


Fig. 3–1: 用 VSUP 调制编程

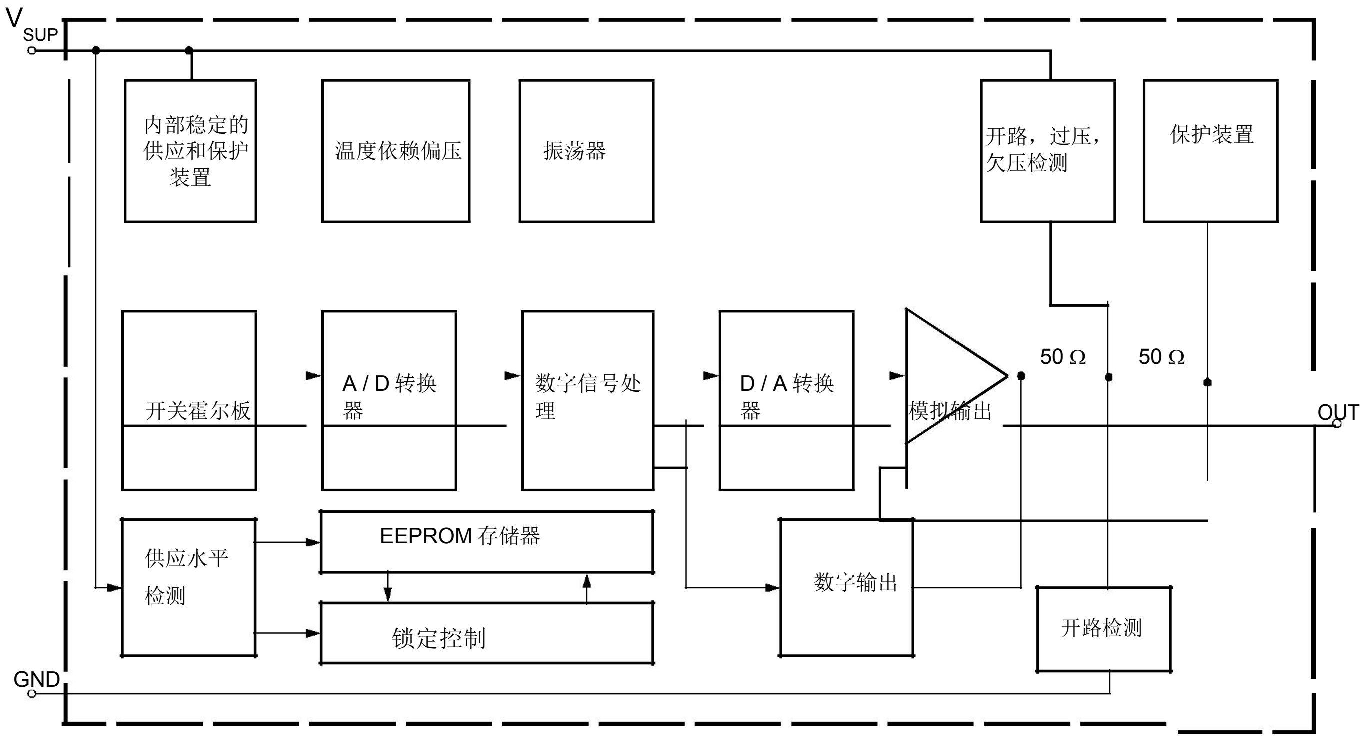


Fig. 3–2: HAL83x 框图

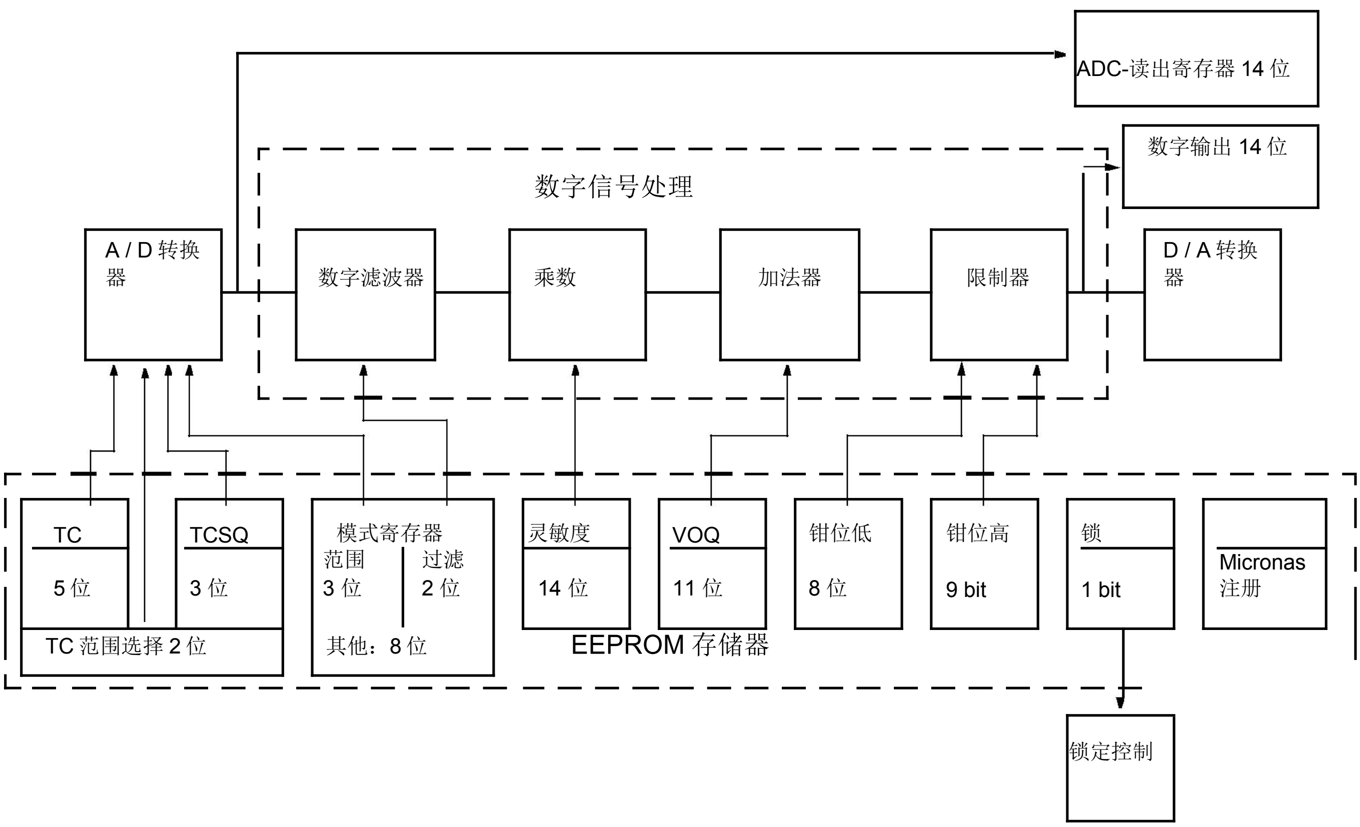


Fig. 3–3: EEPROM 寄存器和数字信号处理的详情

3.2. 数字信号处理和 EEPROM

DSP 执行信号调节并允许传感器适应客户应用。 DSP 的参数存储在 EEPROM 寄存器中。 细节如图 3-3 所示。

术语:

灵敏度：寄存器或寄存器值的名称

灵敏度：参数的名称

EEPROM 寄存器由四组组成:

组 1 包含用于将传感器适配到磁系统的寄存器：用于选择磁场范围和滤波器频率，TC，TCSQ 和 TC-范围的模式，用于磁灵敏度的温度特性。

组 2 包含用于定义输出特性的寄存器：灵敏度，VOQ，钳位低（最小输出），钳位高（最大输出）和输出模式。 传感器的输出特性由这些参数定义。

– 参数 VOQ（输出静态电压）对应于 B = 0 mT 时的输出信号。

– 灵敏度参数定义磁敏感度：

$$灵敏度 = \frac{\Delta V_{OUT}}{\Delta B}$$

– 输出电压可以计算为：

$$V_{OUT} \sim 灵敏度 \times B + V_{OQ}$$

输出电压范围可以通过设置寄存器 CLAMP-LOW 和 CLAMP-HIGH 来钳位，以便启用故障检测（例如 VSUP 或 GND 短路和开路连接）。

第 3 组包含通用寄存器 GP。 GP 寄存器可用于存储客户信息，如制造后的序列号。 Micronas 将使用此 GP REGISTER 存储批号，晶圆号，晶圆上晶粒的 x 和 y 位置等信息。此信息可由客户读取并存储在其自己的数据库中，或可保留 传感器原样。

组 4 包含用于锁定所有寄存器的 Micronas 寄存器和 LOCK。 MICRONAS 寄存器在生产过程中被编程和锁定。 这些寄存器用于振荡器频率调整，A / D 转换器偏移补偿以及其他几种特殊设置。

外部磁场在霍尔板上产生霍尔电压。 ADC 将放大的正或负霍尔电压（在封装品牌侧的磁北极和南极运行）转换为数字值。 该值可以通过 A / D-READOUT 寄存器读取，以确保实现合适的转换器调制。 数字信号在内部低通滤波器中滤波，并根据存储在 EEPROM 中的设置进行操作。 信号处理后的数字值可在 D / A-READOUT 寄存器中读取。 根据霍尔 IC 的可编程磁场范围，A / D 转换器的工作范围为-15 mT ... + 15 mT 至 - 150 mT ... + 150 mT。

在进一步的处理过程中，数字信号与灵敏度系数成倍增加，增加到静态输出电压电平，并根据钳位电压电平进行限制。 结果转换为模拟信号，并通过推挽输出晶体管阶段进行稳定。

任何给定磁场的 D / A-READOUT 取决于编程的磁场范围，低通滤波器，TC 值和 CLAMP-LOW 和 CLAMP-HIGH。 D / A-READOUT 范围最小。 0 和最大。 16383。

注意： 在应用设计中，应该考虑到最大和最小 D / A-READOUT 不应该违反操作范围的误差带。

MODE 寄存器

MODE 寄存器包含用于配置 A / D 转换器和不同输出模式的所有位。

Table 3–1: HAL830 / HAL835 的 MODE 寄存器

模式										
位号	9	8	7	6	5	4	3	2	1	0
参数	范围	保留的	输出模式			过滤		范围） （连同位 9）		保留的

磁场

RANGE 位定义 A / D 转换器的磁场范围。

Table 3–2: 磁性范围 HAL 835

磁场	范围	
模式	模式 [9]	模式 [2:1]
15 mT	1	00
30 mT	0	00
40 mT	1	10
60 mT	0	01
80 mT	0	10
100 mT	0	11
150 mT	1	11

Table 3–3: 磁性范围HAL 830

磁场	范围	
	模式 [9]	模式 [2:1]
30 mT	0	00
40 mT	1	10
60 mT	0	01
80 mT	0	10
100 mT	0	11
150 mT	1	11

过滤

FILTER 位定义数字低通滤波器的-3 dB 频率。

Table 3–4: FILTER 位定义了-3 dB 的频率

–3 dB 频率	模式 [4:3]
80 Hz	00
500 Hz	10
1 kHz	11
2 kHz	01

输出格式

OUTPUTMODE 位定义 HAL83x 的不同输出模式。

Table 3–5: HAL835 的输出模式

输出格式	模式 [7:5]
模拟输出（12 位）	000
多路模拟输出（连续）	001
多路模拟输出（外部触发）	011
老化模式	010
PWM	110
PWM（反极性）	111

Table 3–6: HAL830 的输出模式

输出格式	模式 [7:5]
模拟输出（12 位）	000

在**模拟输出**模式下，传感器提供介于 0 V 和 5 V 之间的比例度量 12 位模拟输出电压。

在**多路模拟输出**模式下，传感器提供两个模拟 7 位值。输出值的 LSN（最不重要的笔尖）和 MSN 分开传输。这使得传感器能够向 ECU 的 8 位 A / D 转换器发送 14 位信号，从而在干扰环境中实现更高的信噪比。

– 在外部触发模式下，ECU 可以通过改变传感器输出的电流方向来切换传感器在 LSN 和 MSN 之间的输出。 如果输出被 10 k 电阻拉高，传感器将发送 MSN。 如果输出被拉下，传感器将发送 LSN。 最大刷新率约为 500 Hz（2 ms）。
– 在连续模式下，传感器连续发送第一个 LSN，然后发送 MSN，并且 ECU 必须收听由传感器发送的数据流。

在多路模拟输出模式下，1 LSB 表示为 39 mV 的电压电平变化。 在模拟输出模式下，14 位 1 LSB 将为 0.31 mV。

在**老化模式**下，传感器 DSP 的信号路径在没有施加磁场的情况下在内部受到刺激。 在这种模式下，传感器提供“锯齿”形状输出信号。 锯齿信号的形状和频率取决于传感器的编程。

这种模式可用于定制生产线的老化测试.

在 **PWM** 模式下，传感器提供 11 位 PWM 输出。 PWM 周期为 8 ms，输出信号将在 0 V 和 5 V 电源电压之间变化。 磁场信息在 PWM 信号的占空比中编码。 占空比定义为 PWM 信号的高电平时间“s”和周期“d”之间的比率（见图 3-1）.

注意： PWM 信号在上升沿更新。 如果使用微控制器评估占空比，则测量值的触发电平应为下降沿。 请使用上升沿来测量 PWM 周期。

对于 PWM（反相），占空比值然后反转。 这意味着正常 PWM 模式下的 70％占空比在 PWM（反相）模式下为 30％占空比。

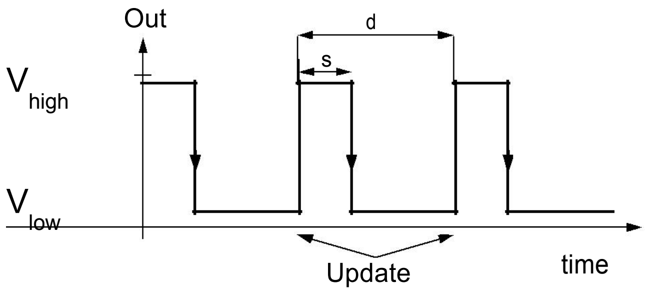


Fig. 3–1: PWM 信号的定义

TC 寄存器

磁敏感度的温度依赖性可以适应不同的磁性材料，以便补偿磁性强度随温度的变化。 通过编程 TC（温度系数）和 TCSQ 寄存器（二次温度系数）完成适配。 因此，磁敏感度的温度依赖性的斜率和曲率可以与磁体和传感器组件匹配。 结果，输出电压特性在整个温度范围内可以保持恒定。 该传感器可以补偿约-3100ppm / K 至 1000 ppm / K 的线性温度系数和约-7 ppm /K²至 2 ppm /K²的二次系数。

完整的 TC 范围在以下四个 TC 范围组中分开（参见第 27 页上的表 3-7 和表 5-1）。

Table 3–7: TC-范围组

TC-范围 [ppm/k]	**TC-范围组** 另请参见第 27 页的表 5-1）
–3100 to –1800	0
–1750 to –550	2
–500 to +450 （默认值）	1
+450 to +1000	3

TC（5 位）和 TCSQ（3 位）必须在四个范围的每一个范围内单独选择。 例如，0 ppm / k 需要 TC-范围= 1，TC = 15 和 TCSQ = 1。请参阅第 5.3 节。 更多细节。

灵敏度

SENSITIVITY 寄存器包含 DSP 中乘法器的参数。 灵敏度可在 4 和 4 之间编程。对于 VSUP = 5 V，寄存器可以按 0.00049 步进行更改。

For all calculations, the digital value from the magnetic field of the D/A converter is used. This digital information is readable from the D/A-READOUT register.

$$\text{灵敏度} = \frac{\Delta VOUT \times 16383}{\Delta DA\text{-}Readout \times VDD} \times Sens_{INITIAL}$$

VOQ

VOQ 寄存器包含 DSP 中加法器的参数。 VOQ 是无外部磁场（B = 0 mT）的输出信号，可从–V_{SUP}（–100% 占空比） 直至 V_{SUP} (100% 占空比)编程。 对于 V_{SUP} = 5 V，寄存器可以以 4.9 mV （0.05% 占空比）。

注意： 如果 V_{OQ} 编程为负值，则最大输出信号被限制为：

$$V_{OUTmax} = V_{OQ} + V_{SUP}$$

夹紧水平

可以钳制输出信号范围以检测故障，如 VSUP 或 GND 短路或开路。

CLAMP-LOW 寄存器包含下限参数。 较低的钳位极限可在 0 V（最小占空比）和 VSUP / 2（50％占空比）之间编程。 对于 VSUP = 5 V，寄存器可以以 9.77 mV（0.195％占空比）。

CLAMP-HIGH 寄存器包含用于上限的参数。 上钳位电压可在 0 V（最小占空比）和 VSUP（最大占空比）之间编程。 对于 VSUP = 5 V，以 9.77 mV（0.195％占空比）。

GP 注册

该寄存器可用于存储一些信息，如生产日期或客户序列号。 Micronas 会在寄存器 GP1 到 GP3 中存储批次编号，晶圆编号和 x，y 坐标。 总寄存器包含四个长度为 13 位的块。客户可以读出这些信息并将其存储在他的生产数据库中以供参考，或者他可以存储自己的生产信息。

注意：该注册不是可追溯性的保证。

要读取/写入该寄存器，必须从 GP0 开始逐个读取/写入所有 GP 寄存器。 在写寄存器的情况下，有必要首先写下所有寄存器，并在最后写一个存储序列。 即使只应更改 GP0，也必须首先读取其他 GP 寄存器，并且必须将读出的数据重新写入这些寄存器。

锁定

通过设置 1 位寄存器，所有寄存器将被锁定，传感器将不再响应任何电源电压调制。 在设置锁定位后，该位在第一次关机和上电序列后激活。

警告： 该寄存器不能被重置！

D/A-READOUT

该 14 位寄存器提供信号处理后所施加磁场的实际数字值。 该寄存器可以被读出，并且是系统环境中传感器校准过程的基础。

注意： 与其他所有寄存器相比，MSB 和 LSB 都相反。请在读出后反转此注册表。

注意： **HAL835：**在校准期间，必须选择模拟输出作为输出格式。 D / A 读出寄存器只能在模拟输出模式下读出。 对于所有其他模式，从传感器读回的结果将为 0.校准后，输出格式可轻松切换到所需的输出模式，如 PWM。

3.3. 校准程序

3.3.1. 一般程序

为了在系统环境中进行校准，建议使用 Micronas 的应用套件。 它包含用于生成用于编程的串行报文（编程器板版本 5.1）和用于输入寄存器值的相应软件（PC83x）的硬件。

对于客户应用中每个传感器的单独校准，建议使用两点调整。 校准过程如下：

步骤 1：输入不需要单独调整的寄存器

该应用给出了磁路，具有温度特性的磁性材料，滤波器频率，输出模式和 GP 寄存器值。 因此，对于客户应用的所有传感器，以下寄存器块的值应该相同。

– 过滤
（根据最大信号频率）

– 范围
（根据传感器位置处的最大磁场）

– 输出模式

– TC, TCSQ 和 TC-范围
（取决于磁体的材料和应用的其他温度依赖性）

– GP
（如果客户想存储自己的生产信息，则不需要更改该寄存器）

随着钳位水平的提供。 它们对 D / A 读数值有影响，因此必须在调整过程之后进行设置。

将适当的设置写入 HAL83x 寄存器。

Step 2: 初始化 DSP

由于 D / A-READOUT 寄存器的值取决于 SENSITIVITY， VOQ 和 CLAMP-LOW / HIGH 的设置，所以这些寄存器必须用定义的值初始化：

– $VOQ_{INITIAL}$ = 2.5 V

– Clamp-Low = 0 V

– Clamp-High = 4.999 V

– $Sens_{INITIAL}$ (see table 3-1.)

Table 3–1:

3dB 滤波器频率	$Sens_{INITIAL}$
80 Hz	0.6
500 Hz	0.39
1 kHz	0.42
2 kHz	0.83

Step 3: 定义校准点

校准点 1 和 2 可以设置在指定范围内。 VOUT1 和 VOUT2 的相应值取决于应用要求。

$$低钳位电压 \le VOUT1{,}2 \le 高钳位电压$$

为了获得最高精度的传感器，建议在最小和最大输入信号附近的校准点。 校准点 1 和校准点 2 之间的输出电压差应大于 3.5 V。

Step 4: VOQ 和灵敏度的计算

将系统设置为校准点 1 并读取寄存器 D / A-READOUT。 结果是值 D / A-READOUT1。

现在，将系统设置为校准点 2，再次读取寄存器 D / A-READOUT，并获取值 D / A-READOUT2。

利用这些值和目标值 VOUT1 和 VOUT2，分别针对校准点 1 和 2，灵敏度和 VOQ 的值被计算为。

$$Sensitivity = Sens_{INITIAL} \times \frac{(Vout2 - Vout1)}{(\text{D/A-Readout2} - \text{D/A-Readout1})} \times \frac{16384}{5}$$

$$VOQ = \frac{1}{16} \times \left[\frac{Vout2 \times 16384}{5} - (\text{D/A-Readout2} - 8192) \times Sensitivity \times \frac{1}{Sens_{INITIAL}} \right] \times \frac{5}{1024}$$

这个计算必须针对每个传感器单独完成。

接下来，将灵敏度和 VOQ 的计算值写入 IC 以调节传感器。 此时，还可以将钳位低电平和钳位高电平的应用特定值存储到传感器 EEPROM 中。传感器现在已针对客户应用进行了校准。 但是，如有必要，编程可以一次又一次地改变。

注意： 对于重新校准，校准过程必须从开始（步骤 1）开始。 新的初始化是必要的，因为步骤 1 中的初始值在步骤 4 中被覆盖。

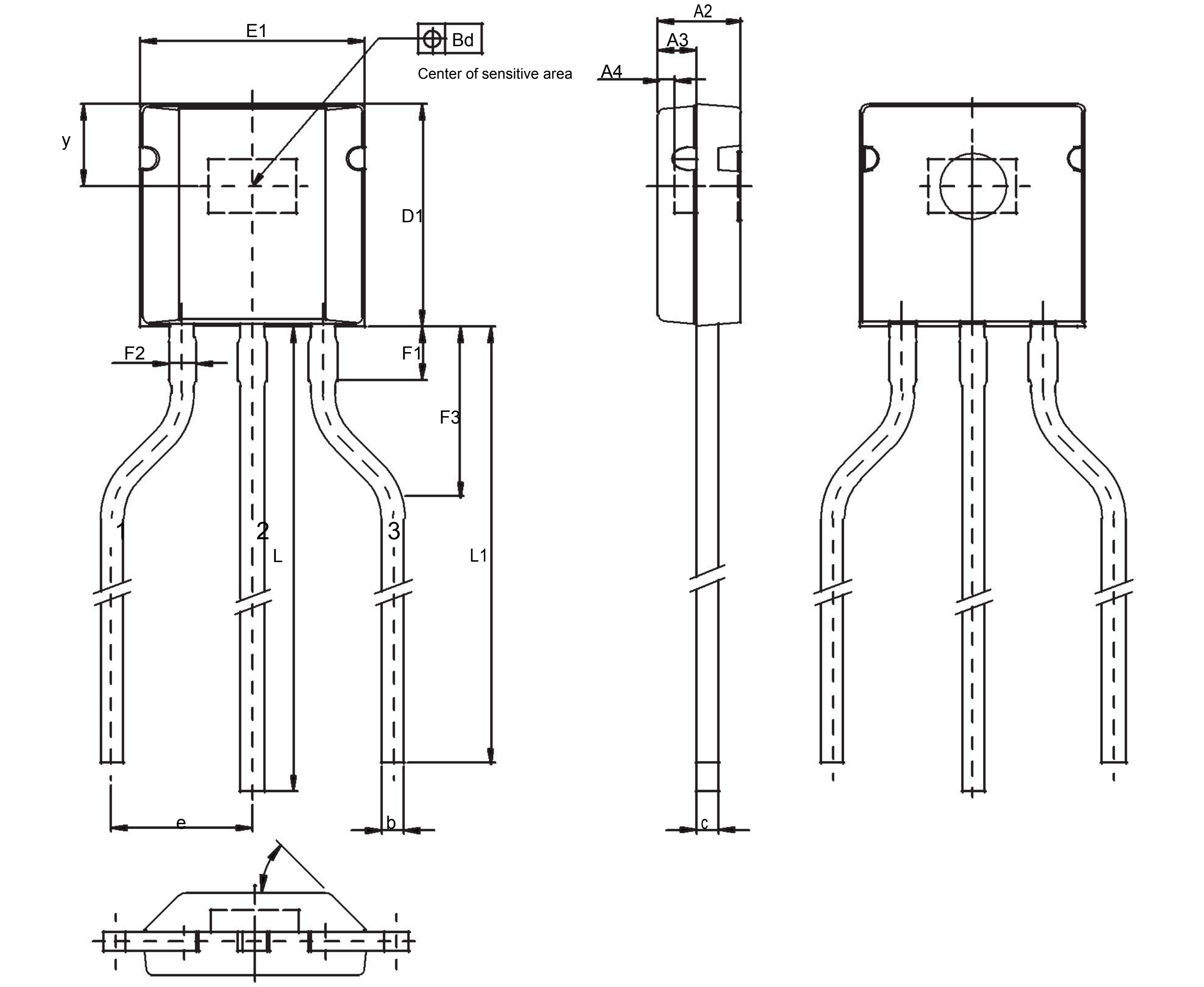
Step 5:锁定传感器

最后一步是通过编程 LOCK 位来激活 LOCK 功能。 请注意，LOCK 功能在掉电和上电霍尔 IC 后生效。 传感器现在被锁定，不会响应任何编程或阅读命令。

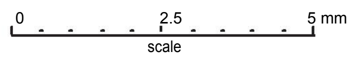
警告： 该寄存器不能被重置！

4. 产品规格

4.1. 外形尺寸



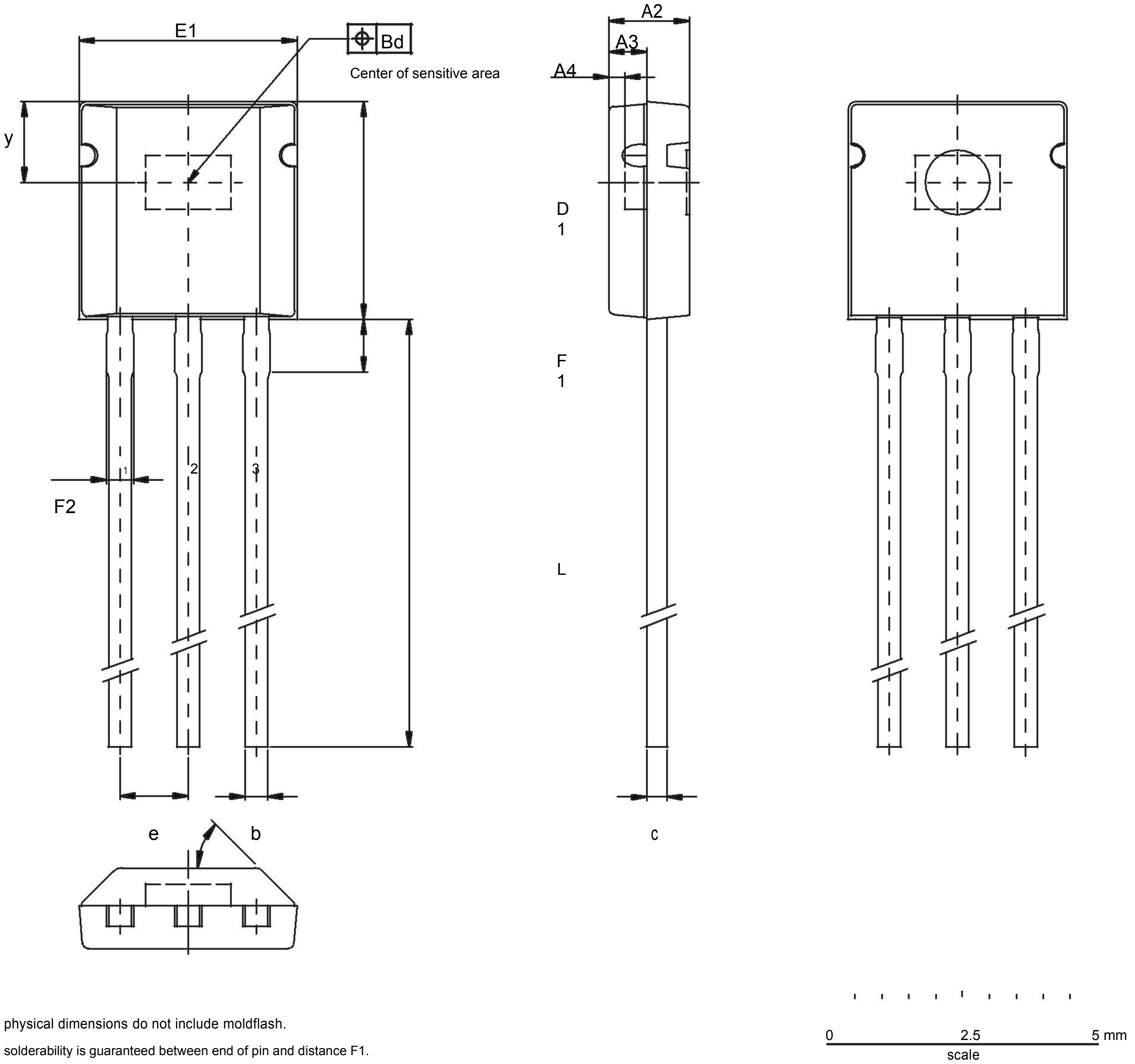
physical dimensions do not include moldflash.
solderability is guaranteed between end of pin and distance F1.
Sn-thickness might be reduced by mechanical handling.
A4, Bd, y= these dimensions are different for each sensor type and are specified in the data sheet.
min/max of D1 are specified in the datasheet.



UNIT	A2	A3	b	c	D1	e	E1	F1	F2	F3	L	L1	Θ
mm	1.55 1.45	0.7	0.42	0.36	4.05	2.54	4.11 4.01	1.2 0.8	0.60 0.42	4.0 2.0	14.5 min	14.0 min	45°

JEDEC STANDARD		ANSI	ISSUE DATE YY-MM-DD	DRAWING-NO.	ZG-NO.
ISSUE	ITEM NO.				
-	-		10-04-29	06609.0001.4	ZG001009_Ver.0 7

Fig. 4–1:
TO92UT-1 Plastic Transistor Standard UT package, 3 leads, spread
Weight approximately 0.12 g



physical dimensions do not include moldflash.

solderability is guaranteed between end of pin and distance F1.

Sn-thickness might be reduced by mechanical handling.

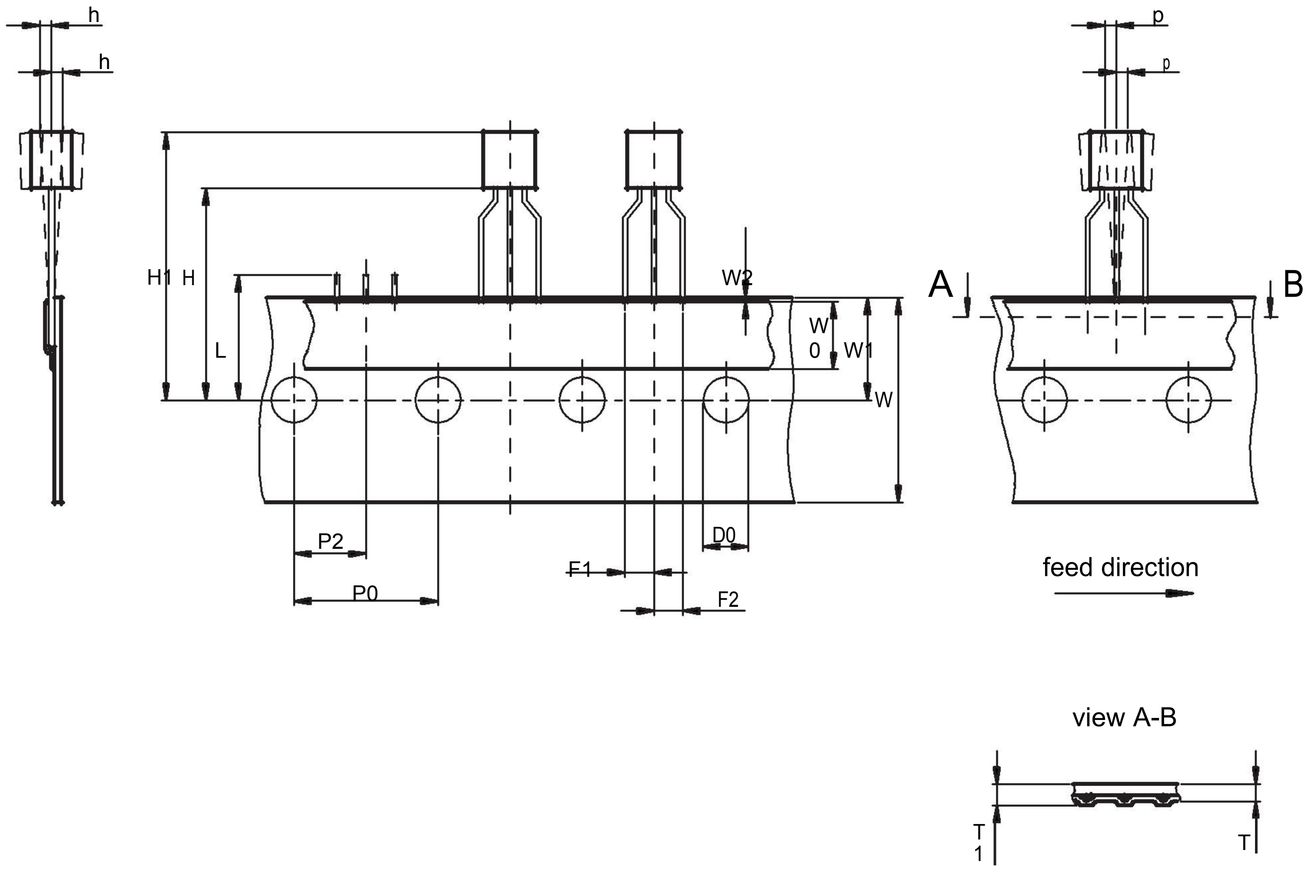
A4, Bd, y= these dimensions are different for each sensor type and are specified in the data sheet.

min/max of D1 are specified in the datasheet.

UNIT	A2	A3	b	c	D1	e	E1	F1	F2	L	Θ
mm	1.55 1.45	0.7	0.42	0.36	4.05	1.27	4.11 4.01	1.2 0.8	0.60 0.42	14.5 min	45°

JEDEC STANDARD		ANSI	ISSUE DATE YY-MM-DD	DRAWING-NO.	ZG-NO.
ISSUE	ITEM NO.				
-	-		15-01-09	06615.0001.4 Bl. 1	ZG001015_Ver.0 8

Fig. 4–2:
TO92UT-2 Plastic Transistor Standard UT package, 3 pins
Weight approximately 0.12 g

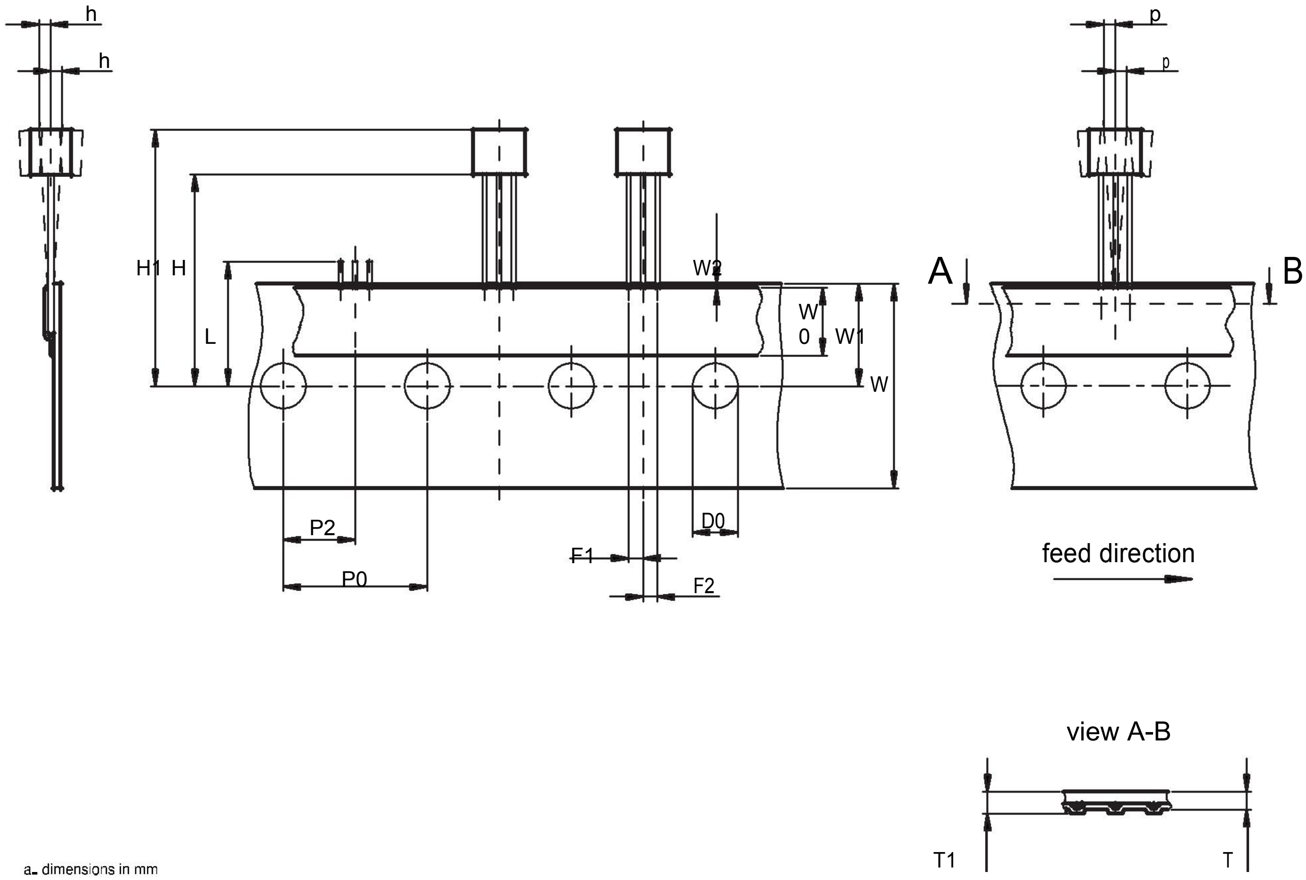


all dimensions in mm
other dimensions see drawing of bulk
max. allowed tolerance over 20 hole spacings ±1.0
H1= this dimension is different for each sensor type and is specified in the data sheet

UNIT	D0	F1	F2	H	h	L	P0	P2	p	T	T1	W	W0	W1	W2
mm	4.0	2.74 2.34	2.74 2.34	20.0 18.0	±1.0	11.0 max	13.2 12.2	7.05 5.65	±1.0	0.5	0.9	18.0	6.0	9.0	0.3

JEDEC STANDARD		ANSI	ISSUE DATE YY-MM-DD	DRAWING-NO.	ZG-NO.
ISSUE	ITEM NO.				
-	ICE 60286-2		15-01-09	06632.0001.4 Bl. 1	ZG001032_Ver.05

Fig. 4–3:
TO92UA/UT: Dimensions ammopack inline, spread



a. dimensions in mm
other dimensions see drawing of bulk
max. allowed tolerance over 20 hole spacings ±1.0
H1= this dimension is different for each sensor type and is specified in the data sheet

UNIT	D0	F1	F2	H	h	L	P0	P2	p	T	T1	W	W0	W1	W2
mm	4.0	1.47 1.07	1.47 1.07	20.0 18.0	±1.0	11.0 max	13.2 12.2	7.05 5.65	±1.0	0.5	0.9	18.0	6.0	9.0	0.3

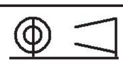
STANDARD		ANSI	ISSUE DATE YY-MM-DD	DRAWING-NO.	ZG-NO.
ISSUE	ITEM NO.				
-	IEC 60286-2		15-01-09	06631.0001.4 Bl. 1	ZG001031_Ver.04

Fig. 4–4:
TO92UA/UT: Dimensions ammopack inline, not spread

4.2. Soldering, Welding and Assembly

Information related to solderability, welding, assembly, and second-level packaging is included in the document "Guidelines for the Assembly of Micronas Packages". It is available on the Micronas website or on the service portal.

4.3. Pin Connections and Short Descriptions

Pin No.	Pin Name	Type	Short Description
1	VSUP	SUPPLY	Supply Voltage and Programming Pin
2	GND	GND	Ground
3	OUT	I/O	Push-Pull Output and Selection Pin

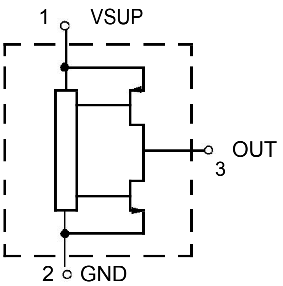


Fig. 4–5: Pin configuration

4.4. Dimensions of Sensitive Area

0.25 mm x 0.25 mm

4.5. Physical Dimensions

	TO92UT-2
A4	0.3 mm nominal
Bd	0.3 mm
D1	4.05 mm ± 0.05 mm
H1	min. 22.0 mm max. 24.1 mm
y	1.5 mm nominal

4.6. Absolute Maximum Ratings

Stresses beyond those listed in the "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only. Functional operation of the device at these conditions is not implied. Exposure to absolute maximum rating conditions for extended periods will affect device reliability.

This device contains circuitry to protect the inputs and outputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than abso-lute maximum-rated voltages to this circuit.

All voltages listed are referenced to ground (GND).

Symbol	Parameter	Pin No.	Min.	Max.	Unit	Condition
V_{SUP}	Supply Voltage	1	–8.5	8.5	V	t < 96 h[3)]
V_{SUP}	Supply Voltage	1	–16	16	V	t < 1 h[3)]
V_{OUT}	Output Voltage	3	–5	16	V	
$V_{OUT} - V_{SUP}$	Excess of Output Voltage over Supply Voltage	3,1	–	2	V	
I_{OUT}	Continuous Output Current	3	–10	10	mA	
t_{Sh}	Output Short Circuit Duration	3	–	10	min	
V_{ESD}	ESD Protection[1)]	1 3	–8 –7.5	8 7.5	kV	
TJ	Junction Temperature under bias[2)]		–50	190	°C	

1) AEC-Q100-002 (100 pF and 1.5 kΩ)
2) For 96 h - Please contact Micronas for other temperature requirements
3) No cumulated stress

4.6.1. Storage and Shelf Life

Information related to storage conditions of Micronas sensors is included in the document “Guidelines for the Assembly of Micronas Packages”. It gives recommendations linked to moisture sensitivity level and long-term storage. It is available on the Micronas website or on the service portal.

4.7. Recommended Operating Conditions

Functional operation of the device beyond those indicated in the “Recommended Operating Conditions/Characteristics” is not implied and may result in unpredictable behavior, reduce reliability and lifetime of the device.

All voltages listed are referenced to ground (GND).

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit	Condition
V_{SUP}	Supply Voltage	1	4.5 12.4	5 12.5	5.5 12.6	V	 During programming
I_{OUT}	Continuous Output Current	3	–1.2	–	1.2	mA	
R_L	Load Resistor	3	4.5	10	–	kΩ	Can be pull-up or pull-down resistor
C_L	Load Capacitance	3	0	100	1000	nF	Analog output only
N_{PRG}	Number of EEPROM Programming Cycles	–	–	–	100	cycles	0°C < T_{amb} < 55°C
TJ	Junction Temperature Range[1)]	–	–40 –40 –40	– – –	125 150 170	°C °C °C	for 8000 h[2)] for 2000 h[2)] for 1000 h[2)]

[1)] Depends on the temperature profile of the application. Please contact Micronas for life time calculations.
[2)] Time values are not cumulative

4.8. Characteristics

at T_J = –40 °C to +170 °C, V_{SUP} = 4.5 V to 5.5 V, GND = 0 V after programming and locking, at Recommended Operation Conditions if not otherwise specified in the column "Conditions".
Typical Characteristics for T_J = 25 °C and V_{SUP} = 5 V.

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit	Conditions
I_{SUP}	Supply Current over Temperature Range	1	5	7	10	mA	
ES	Error in Magnetic Sensitivity over Temperature Range[5]	3	–4 –1	0 0	4 1	%	HAL830 HAL835 V_{SUP} = 5 V; 60 mT range, 3db frequency = 500 Hz, TC & TCSQ for linearized temperature coefficients (see Section 4.8.1. on page 23)
Analog Output (HAL830 & HAL835)							
	Resolution	3	–	12	–	bit	ratiometric to V_{SUP} [1]
DNL	Differential Non-Linearity of D/A converter[2]	3	–2.0 –1.5	0 0	2.0 1.5	LSB	HAL830 HAL835 Only @ 25°C ambient temperature
INL	Non-Linearity of Output Voltage over Temperature	3	–0.5	0	0.5	%	% of supply voltage[3] For V_{OUT} = 0.35 V ... 4.65 V; V_{SUP} = 5 V, Sensitivity ≤ 0.95
E_R	Ratiometric Error of Output over Temperature (Error in V_{OUT} / V_{SUP})	3	–0.25	0	0.25	%	$\lvert V_{OUT1} - V_{OUT2} \rvert > 2\ V$ during calibration procedure
V_{Offset}	Offset Drift over Temperature Range $V_{OUT}(B = 0\ mT)_{25°C} - V_{OUT}(B = 0\ mT)_{max}$ [5]	3	–0.6 –0.2	0.25 0.1	0.6 0.2	% V_{SUP}	HAL830 HAL835 V_{SUP} = 5 V; 60 mT range, 3dB frequency = 500 Hz, TC = 15, TCSQ = 1, TC-Range = 1 –0.65 < sensitivity < 0.65
ΔV_{OUTCL}	Accuracy of Output Voltage at Clamping Low Voltage over Temperature Range	3	–15	0	15	mV	R_L = 5 kΩ, V_{SUP} = 5 V Spec values are derived from resolutions of the registers Clamp-Low/Clamp-High and the parameter Voffset
ΔV_{OUTCH}	Accuracy of Output Voltage at Clamping High Voltage over Temperature Range	3	–15	0	15	mV	
V_{OUTH}	Upper Limit of Signal Band[4]	3	4.65	4.8	–	V	V_{SUP} = 5 V, –1 mA ≤ I_{OUT} ≤ 1mA
V_{OUTL}	Lower Limit of Signal Band[4]	3	–	0.2	0.35	V	V_{SUP} = 5 V, –1 mA ≤ I_{OUT} ≤ 1mA
R_{OUT}	Output Resistance over Recommended Operating Range	3	–	1	10	Ω	$V_{OUTLmax} \le V_{OUT} \le V_{OUTHmin}$
$t_{r(O)}$	Step Response Time of Output[6]	3	–	3.0 1.5 1.1 0.9	–	ms	3 dB Filter frequency = 80 Hz 3 dB Filter frequency = 500 Hz 3 dB Filter frequency = 1 kHz 3 dB Filter frequency = 2kHz C_L = 10 nF, time to 90% of final output voltage for a steplike signal B_{step} from 0 mT to B_{max}
t_{POD}	Power-Up Time (Time to reach stable Output Voltage)	–	1.5	1.7	1.9	ms	C_L = 10 nF, 90% of V_{OUT}

1) Output DAC full scale = 5 V ratiometric, Output DAC offset = 0 V, Output DAC LSB = V_{SUP}/4096
2) Only tested at 25°C. The specified values are test limits only. Overmolding and packaging might influence this parameter
3) If more than 50% of the selected magnetic field range is used (Sensitivity ≤ 0.5) and the temperature compensation is suitable. INL = $V_{OUT} - V_{OUTLSF}$ = Least Square Fit Line voltage based on V_{OUT} measurements at a fixed temperature.
4) Signal Band Area with full accuracy is located between V_{OUTL} and V_{OUTH}. The sensor accuracy is reduced below V_{OUTL} and above V_{OUTH}
5) $T_{ambient}$ = 150°C
6) Guaranteed by design

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit	Conditions
BW	Small Signal Bandwidth (−3 dB)	3	–	2	–	kHz	B_{AC} < 10 mT; 3 dB Filter frequency = 2 kHz
V_{OUTn}	Noise Output Voltage$_{RMS}$	3	–	1	5	mV	magnetic range = 60 mT 3 dB Filter frequency = 500 Hz Sensitivity ≤ 0.7; C = 4.7 nF (V_{SUP} & V_{OUT} to GND)
DACGE	D/A-Converter Glitch Energy	3	–	40	–	nV	7)
PWM Output (HAL835 only)							
	Resolution	3	–	11	–	bit	
$\Delta DC_{MIN-DUTY}$	Accuracy of Duty Cycle at Clamp Low over Temperature Range	3	−0.3	0	0.3	%	Spec values are derived from resolutions of the registers Clamp-Low/Clamp-High and the parameter $DC_{OQoffset}$
$\Delta DC_{MAX-DUTY}$	Accuracy of Duty Cycle at Clamp High over Temperature Range	3	−0.3	0	0.3	%	
V_{OUTH}	Output High Voltage	3	–	4.8	–	V	V_{SUP} = 5 V, −1 mA ≤ I_{OUT} ≤ 1mA
V_{OUTL}	Output Low Voltage	3	–	0.2	–	V	V_{SUP} = 5 V, −1 mA ≤ I_{OUT} ≤ 1mA
f_{PWM}	PWM Output Frequency over Temperature Range	3	105	125	145	Hz	
t_{POD}	Power-Up Time (Time to reach valid Duty Cycle)	3	–	–	8.5	ms	
$t_{r(O)}$	Step Response Time of Output	3	–	3 0,9 0,6 0,4	13 1,2 0.8 0,5	ms	3 dB Filter frequency = 80 Hz 3 dB Filter frequency = 500 Hz 3 dB Filter frequency = 1 kHz 3 dB Filter frequency = 2kHz Time to 90% of final output voltage for a steplike signal B_{step} from 0 mT to B_{max}
TO92UT Packages							
	Thermal Resistance		–				
R_{thja}	junction to air	–	–	–	235	K/W	Measured with a 1s0p board
R_{thjc}	junction to case	–	–	–	61	K/W	Measured with a 1s0p board

7) The energy of the impulse injected into the analog output when the code in the D/A-Converter register changes state. This energy is normally specified as the area of the glitch in nVs.

4.8.1. Definition of sensitivity error ES

ES is the maximum of the absolute value of the quotient of the normalized measured value[1] over the normalized ideal linear[2] value minus 1:

$$ES = max\left(abs\left(\frac{meas}{ideal} - 1\right)\right)\Bigg|_{\{Tmin,\, Tmax\}}$$

In the example below, the maximum error occurs at −10°C:

$$ES = \frac{1.001}{0.993} - 1 = 0.8\%$$

[1]: normalized to achieve a least-squares method straight line that has a value of 1 at 25°C
[2]: normalized to achieve a value of 1 at 25°C

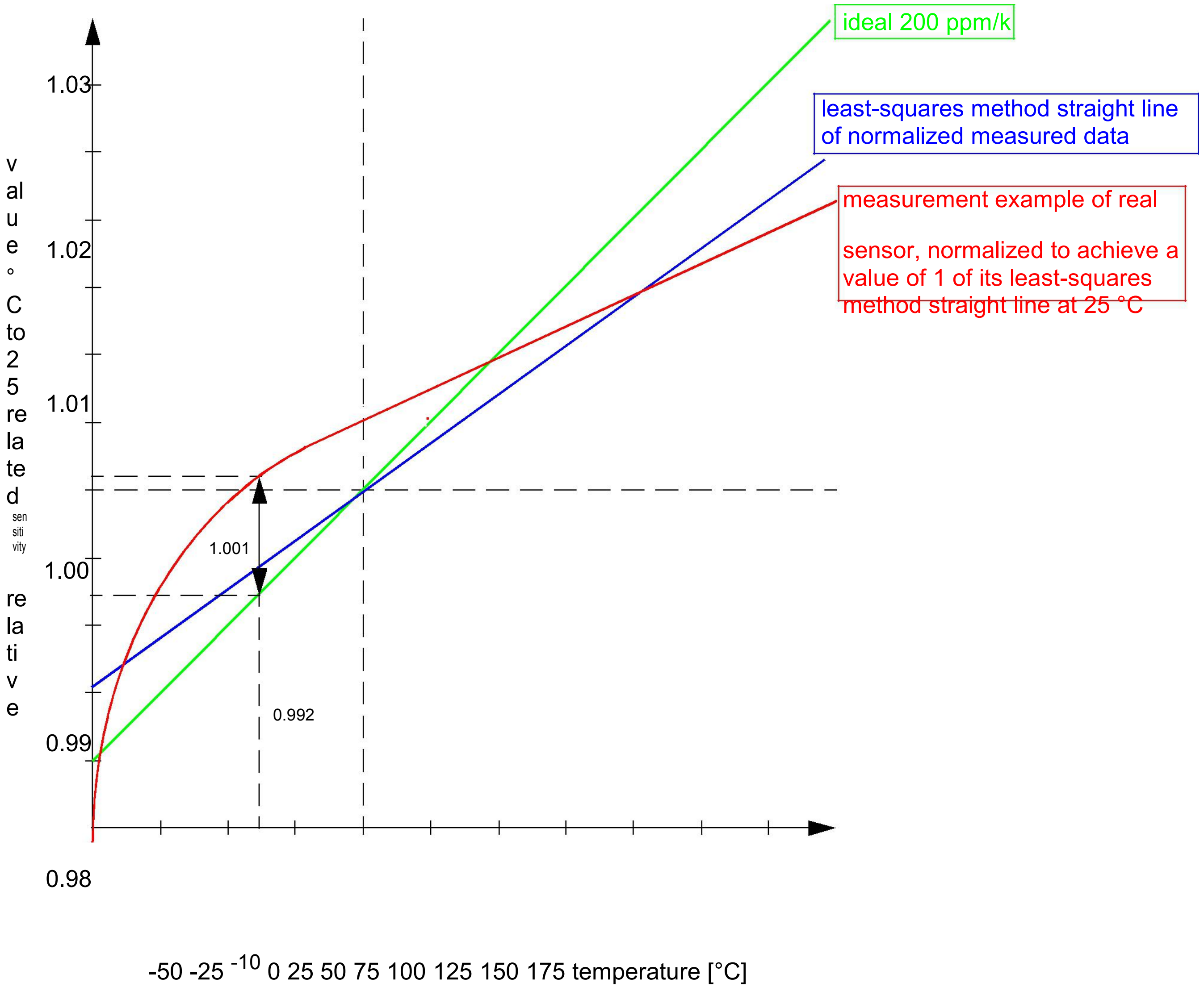


Fig. 4–6: ES definition example

4.8.2. Power-On Operation

at T_J = –40 °C to +170 °C, after programming and locking. Typical Characteristics for T_J = 25 °C.

Symbol	Parameter	Min.	Typ.	Max.	Unit
POR_{UP}	Power-On Reset Voltage (UP)	–	3.4	–	V
POR_{DOWN}	Power-On Reset Voltage (DOWN)	–	3.0	–	V

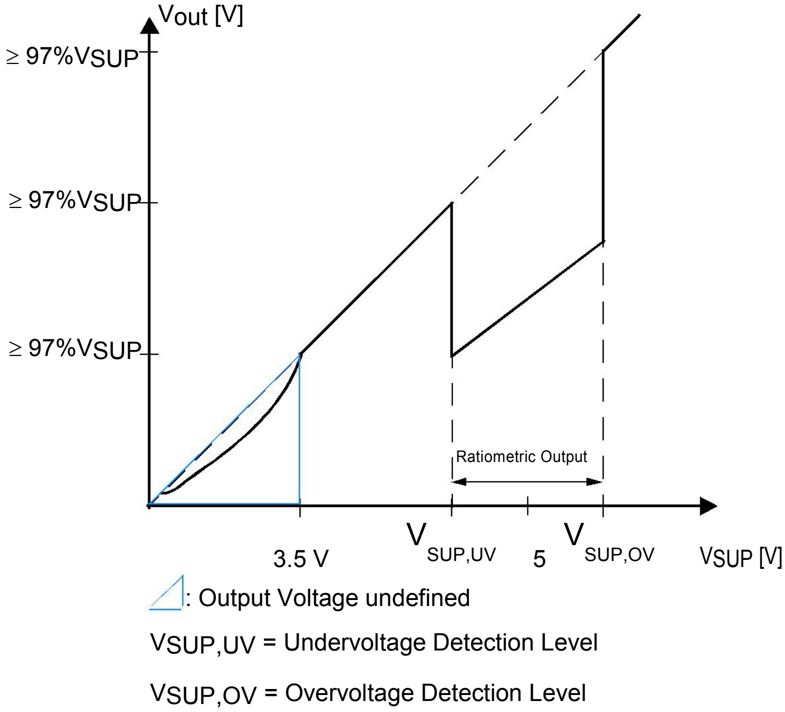


Fig. 4–7: Analog output behavior for different supply voltages

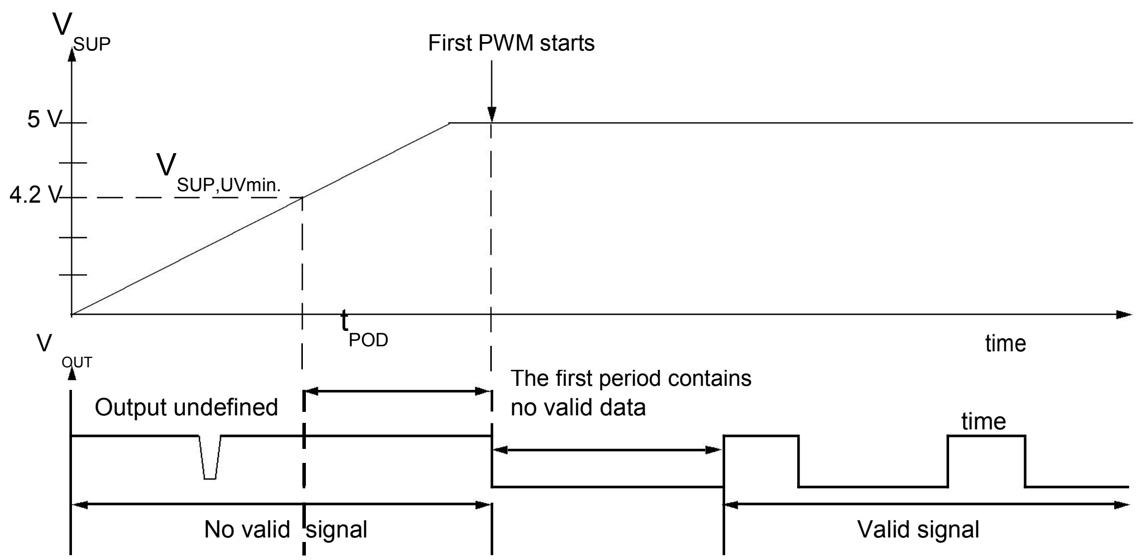


Fig. 4–8: Power-up behavior of HAL835 with PWM output activated

4.9. Diagnostics and Safety Features

4.9.1. Overvoltage and Undervoltage Detection

at T_J = –40 °C to +170 °C, Typical Characteristics for T_J = 25 °C, after programming and locking

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit	Test Conditions
$V_{SUP,UV}$	Undervoltage detection level	1	–	4.2	4.5	V	1)2)
$V_{SUP,OV}$	Overvoltage detection level	1	8.5	8.9	10.0	V	1)2)

1) If the supply voltage drops below $V_{SUP,UV}$ or rises above $V_{SUP,OV}$, the output voltage is switched to V_{SUP} (≥97% of V_{SUP} at R_L = 10 kΩ to GND).
2) If the PWM output of HAL835 is activated, then the output signal will follow VSUP and PWM signal is switched off

Note: The over- and undervoltage detection is activated only after locking the sensor!

4.9.2. Open-Circuit Detection

at T_J = –40 °C to +170 °C, Typical Characteristics for T_J = 25 °C, after locking the sensor.

Symbol	Parameter	Pin No.	Min.	Typ.	Max.	Unit	Comment
V_{OUT}	Output voltage at open V_{SUP} line	3	0	0	0.15	V	V_{SUP} = 5 V R_L = 10 kΩ to 200 kΩ
			0	0	0.2	V	V_{SUP} = 5 V 5 kΩ <= R_L < 10 kΩ
			0	0	0.25	V	V_{SUP} = 5 V 4.5 kΩ <= R_L < 10 kΩ 1)
V_{OUT}	Output voltage at open GND line	3	4.85	4.9	5.0	V	V_{SUP} = 5 V R_L = 10 kΩ to 200 kΩ
			4.8	4.9	5.0	V	V_{SUP} = 5 V 5 kΩ <= R_L < 10 kΩ
			4.75	4.9	5.0	V	V_{SUP} = 5 V 4.5 kΩ <= R_L < 10 kΩ 1)

1) Not tested

Note: In case that the PWM output mode is used the sensor will stop transmission of the PWM signal if V_{SUP} or GND lines are broken and V_{OUT} will be according to above table.

4.9.3. Overtemperature and Short-Circuit Protection

If overtemperature >180 °C or a short-circuit occurs, the output will go into tri-state condition.

4.9.4. EEPROM Redundancy

The non-volatile memory uses the Micronas Fail Safe Redundant Cell technology well proven in automotive applications.

4.9.5. ADC Diagnostic

The A/D-READOUT register can be used to avoid under/overrange effects in the A/D converter.

5. Application Notes

5.1. Application Circuit (for analog output mode only)

For EMC protection, it is recommended to connect one ceramic 100 nF capacitor each between ground and the supply voltage, respectively the output voltage pin.

Please note that during programming, the sensor will be supplied repeatedly with the programming voltage of 12.5 V for 100 ms. All components connected to the V_{SUP} line at this time must be able to resist this voltage.

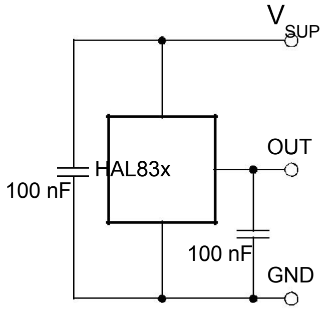


Fig. 5–1: Recommended application circuit (analog output signal)

5.2. Use of two HAL83x in Parallel (for analog output mode only)

Two different HAL83x sensors which are operated in parallel to the same supply and ground line can be pro-grammed individually. In order to select the IC which should be programmed, both Hall ICs are inactivated by the “Deactivate” command on the common supply line. Then, the appropriate IC is activated by an “Acti-vate” pulse on its output. Only the activated sensor will react to all following read, write, and program com-mands. If the second IC has to be programmed, the “Deactivate” command is sent again, and the second IC can be selected.

Note: The multi-programming of two sensors requires a 10 kΩ pull-down resistor on the sensors output pins.

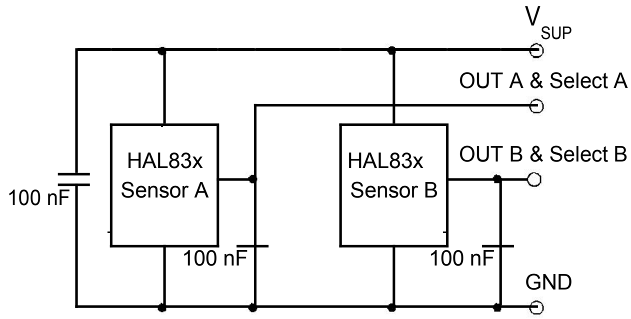


Fig. 5–2: Recommended Application circuit (parallel operation of two HAL83x)

5.3. Temperature Compensation

The relationship between the temperature coefficient of the magnet and the corresponding TC, TCSQ and TC-Range codes for linear compensation is given in the following table. In addition to the linear change of the magnetic field with temperature, the curvature can be adjusted as well. For this purpose, other TC, TCSQ and TC-Range combinations are required which are not shown in the table. Please contact Micronas for more detailed information on this higher order temperature compensation.

Table 5–1: Temperature Compensation

Temperature Coefficient of Magnet (ppm/K)	TC-Range Group	TC	TCSQ
1075	3	31	7
1000	3	28	1
900	3	24	0
750	3	16	2
675	3	12	2
575	3	8	2
450	3	4	2
400	1	31	0
250	1	24	1
150	1	20	1
50	1	16	2
0	1	15	1
–100	1	12	0
–200	1	8	1
–300	1	4	4
–400	1	0	7
–500	1	0	0
–600	2	31	2
–700	2	28	1
–800	2	24	3
–900	2	20	6
–1000	2	16	7
–1100	2	16	2
–1200	2	12	5
–1300	2	12	0
–1400	2	8	3
–1500	2	4	7
–1600	2	4	1
–1700	2	0	6
–1800	0	31	6
–1900	0	28	7
–2000	0	28	2
–2100	0	24	6
–2200	0	24	1
–2400	0	20	0
–2500	0	16	5
–2600	0	14	5
–2800	0	12	1
–2900	0	8	6
–3000	0	8	3
–3100	0	4	7
–3300	0	4	1
–3500	0	0	4

Table 5–1: Temperature Compensation

Note: The above table shows only some approximate values. Micronas recommends to use the TC-Calc software to find optimal settings for temper-ature coefficients. Please contact Micronas for more detailed information.

5.4. Ambient Temperature

Due to the internal power dissipation, the temperature on the silicon chip (junction temperature T_J) is higher than the temperature outside the package (ambient temperature T_A).

$T_J = T_A + \Delta T$

At static conditions and continuous operation, the following equation applies:

$$\Delta T = I_{SUP} * V_{SUP} * R_{thjX}$$

The X represents junction-to-air or junction-to-case.

In order to estimate the temperature difference ΔT between the junction and the respective reference (e.g. air, case, or solder point) use the max. parameters for I_{SUP}, R_{thX}, and the max. value for V_{SUP} from the application.

The following example shows the result for junction-to - air conditions. V_{SUP} = 5.5 V, R_{thja} = 250 K/W and I_{SUP} = 10 mA the temperature difference ΔT = 13.75 K.

The junction temperature T_J is specified. The maxi-mum ambient temperature T_{Amax} can be estimated as:

$$T_{Amax} = T_{Jmax} - \Delta T$$

5.5. EMC and ESD

Please contact Micronas for the detailed investigation reports with the EMC and ESD results.

6. Programming

6.1. Definition of Programming Pulses

The sensor is addressed by modulating a serial tele-gram on the supply voltage. The sensor answers with a serial telegram on the output pin.

The bits in the serial telegram have a different bit time for the V_{SUP}-line and the output. The bit time for the V_{SUP}-line is defined through the length of the Sync Bit at the beginning of each telegram. The bit time for the output is defined through the Acknowledge Bit.

A logical “0” is coded as no voltage change within the bit time. A logical “1” is coded as a voltage change between 50% and 80% of the bit time. After each bit, a voltage change occurs.

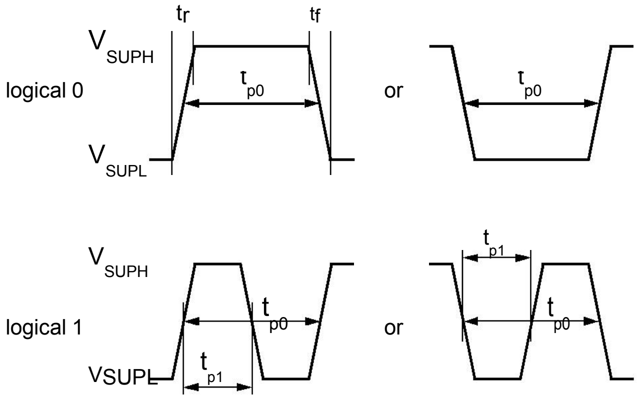


Fig. 6–1: Definition of logical 0 and 1 bit

6.2. Definition of the Telegram

Each telegram starts with the Sync Bit (logical 0), 3 bits for the Command (COM), the Command Parity Bit (CP), 4 bits for the Address (ADR), and the Address Parity Bit (AP).

There are 4 kinds of telegrams:

– Write a register (see Fig. 6–2)
After the AP Bit, follow 14 Data Bits (DAT) and the Data Parity Bit (DP). If the telegram is valid and the command has been processed, the sensor answers with an Acknowledge Bit (logical 0) on the output.

– Read a register (see Fig. 6–3)
After evaluating this command, the sensor answers with the Acknowledge Bit, 14 Data Bits, and the Data Parity Bit on the output.

– Programming the EEPROM cells (see Fig. 6–4)
After evaluating this command, the sensor answers with the Acknowledge Bit. After the delay time t_w, the supply voltage rises up to the programming volt-age.

– Activate a sensor (see Fig. 6–5)
If more than one sensor is connected to the supply line, selection can be done by first deactivating all sensors. The output of all sensors have to be pulled to ground. With an Activate pulse on the appropriate output pin, an individual sensor can be selected. All following commands will only be accepted from the activated sensor.

Table 6–1: Telegram parameters

Symbol	Parameter	Pin	Min.	Typ.	Max.	Unit	Remarks
V_{SUPL}	Supply Voltage for Low Level during Programming	1	5	5.6	6	V	
V_{SUPH}	Supply Voltage for High Level during Programming	1	6.8	8.0	8.5	V	
t_r	Rise time	1	–	–	0.05	ms	see Fig. 6–1 on page 29
t_f	Fall time	1	–	–	0.05	ms	see Fig. 6–1 on page 29
t_{p0}	Bit time on V_{SUP}	1	1.7	1.75	1.9	ms	t_{p0} is defined through the Sync Bit
t_{pOUT}	Bit time on output pin	3	2	3	4	ms	t_{pOUT} is defined through the Acknowledge Bit
t_{p1}	Duty-Cycle Change for logical 1	1, 3	50	65	80	%	% of t_{p0} or t_{pOUT}
$V_{SUPPROG}$	Supply Voltage for Programming the EEPROM	1	12.4	12.5	12.6	V	
t_{PROG}	Programming Time for EEPROM	1	95	100	105	ms	
t_{rp}	Rise time of programming voltage	1	0.2	0.5	1	ms	see Fig. 6–1 on page 29
t_{fp}	Fall time of programming voltage	1	0	–	1	ms	see Fig. 6–1 on page 29
t_w	Delay time of programming voltage after Acknowledge	1	0.5	0.7	1	ms	
V_{act}	Voltage for an Activate pulse	3	3	4	5	V	
t_{act}	Duration of an Activate pulse	3	0.05	0.1	0.2	ms	
Vout,deact	Output voltage after deactivate command	3	0	0.1	0.2	V	

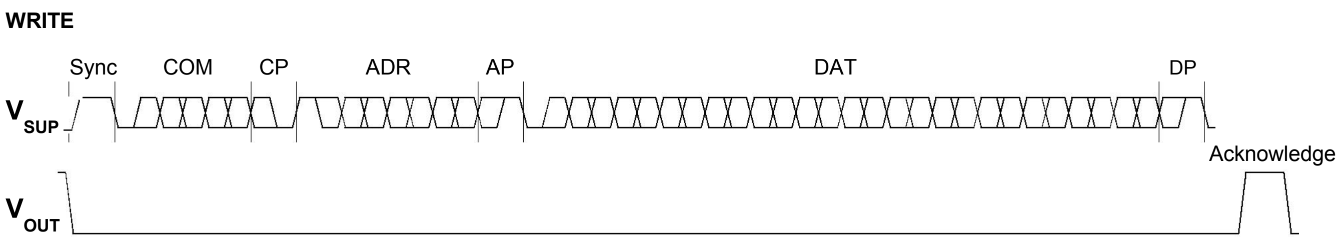


Fig. 6–2: Telegram for coding a Write command

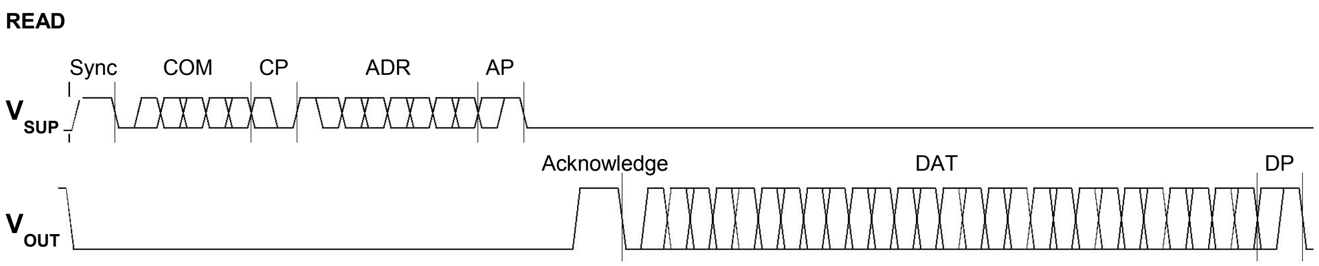


Fig. 6–3: Telegram for coding a Read command

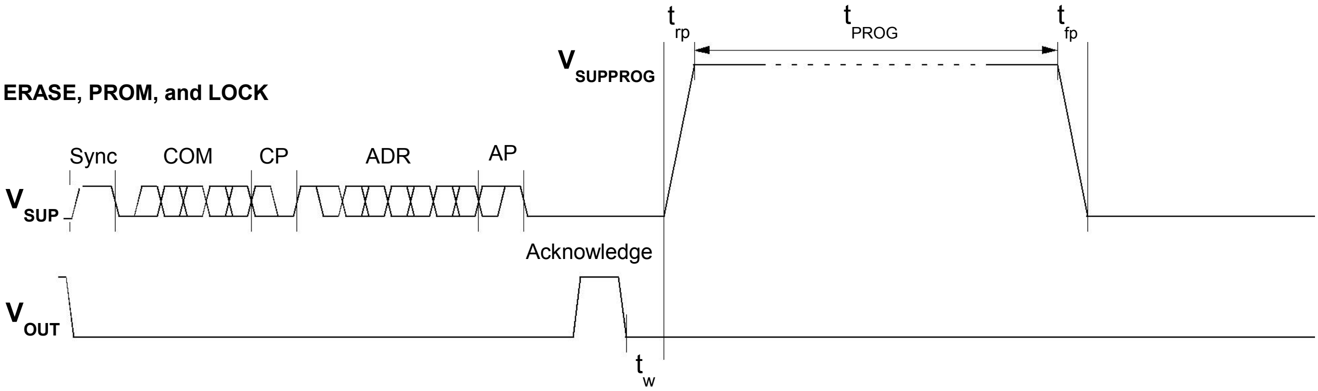


Fig. 6–4: Telegram for coding the EEPROM programming

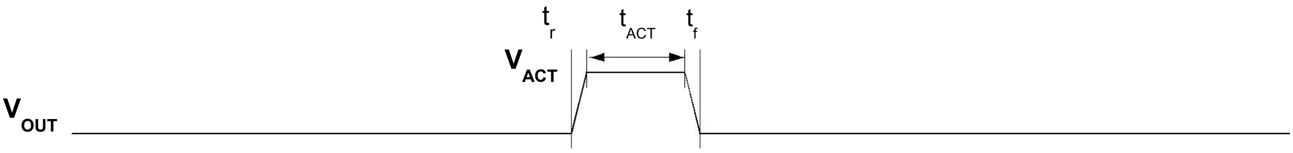


Fig. 6–5: Activate pulse

6.3. Telegram Codes

Sync Bit

Each telegram starts with the Sync Bit. This logical “0” pulse defines the exact timing for t_{p0}.

Command Bits (COM)

The Command code contains 3 bits and is a binary number. Table 6–2 shows the available commands and the corresponding codes for the HAL83x.

Command Parity Bit (CP)

This parity bit is “1” if the number of zeros within the 3 Command Bits is uneven. The parity bit is “0”, if the number of zeros is even.

Address Bits (ADR)

The Address code contains 4 bits and is a binary num-ber. Table 6–3 shows the available addresses for the HAL83x registers.

Address Parity Bit (AP)

This parity bit is “1” if the number of zeros within the 4 Address bits is uneven. The parity bit is “0” if the number of zeros is even.

Data Bits (DAT)

The 14 Data Bits contain the register information.

The registers use different number formats for the Data Bits. These formats are explained in Section 6.4.

In the Write command, the last bits are valid. If, for example, the TC register (10 bits) is written, only the last 10 bits are valid.

In the Read command, the first bits are valid. If, for example, the TC register (10 bits) is read, only the first 10 bits are valid.

Data Parity Bit (DP)

This parity bit is “1” if the number of zeros within the binary number is even. The parity bit is “0” if the number of zeros is uneven.

Acknowledge

After each telegram, the output answers with the Acknowledge signal. This logical “0” pulse defines the exact timing for t_{pOUT}.

Table 6–2: Available commands

Command	Code	Explanation
READ	2	read a register
WRITE	3	write a register
PROM	4	program all non-volatile registers
ERASE	5	erase all non-volatile registers

6.4. Number Formats

Binary number:

The most significant bit is given as first, the least significant bit as last digit.

Example: `101001` represents 41 decimal.

Signed binary number:

The first digit represents the sign of the following binary number (1 for negative, 0 for positive sign).

Example: `0101001` represents +41 decimal

`1101001` represents –41 decimal

Two's-complement number:

The first digit of positive numbers is "0", the rest of the number is a binary number. Negative numbers start with "1". In order to calculate the absolute value of the number, calculate the complement of the remaining digits and add "1".

Example: `0101001` represents +41 decimal

`1010111` represents –41 decimal

6.5. Register Information

CLAMP-LOW

– The register range is from 0 up to 255.

– The register value is calculated by:

$$\text{CLAMP-LOW} = \frac{\text{LowClampingVoltage} \times 2}{V_{SUP}} \times 255$$

CLAMP-HIGH

– The register range is from 0 up to 511.

– The register value is calculated by:

$$\text{CLAMP-HIGH} = \frac{\text{HighClampingVoltage}}{V_{SUP}} \times 511$$

VOQ

– The register range is from –1024 up to 1023.

– The register value is calculated by:

$$VOQ = \frac{V_{OQ}}{V_{SUP}} \times 1024$$

SENSITIVITY

– The register range is from –8192 up to 8191.

– The register value is calculated by:

$$SENSITIVITY = Sensitivity \times 2048$$

TC

– The TC register range is from 0 up to 1023.

– The register value is calculated by:

$$TC = GROUP \times 256 + TCValue \times 8 + TCSQValue$$

MODE

– The register range is from 0 up to 1023 and contains the settings for FILTER, RANGE, OUTPUTMODE:

$$MODE = RANGE(Mode[9]) \times 512 + OUTPUTMODE \times 32 + FILTER \times 8 + RANGE(Mode[2:1]) \times 2$$

D/A-READOUT

– This register is read only.

– The register range is from 0 up to 16383.

DEACTIVATE

– This register can only be written.

– The register has to be written with 2063 decimal (80F hexadecimal) for the deactivation.

– The sensor can be reset with an Activate pulse on the output pin or by switching off and on the supply voltage.

Table 6–3: Available register addresses

Register	Code	Data Bits	Format	Customer	Remark
CLAMP-LOW	1	8	binary	read/write/program	Low clamping voltage
CLAMP-HIGH	2	9	binary	read/write/program	High clamping voltage
VOQ	3	11	two's compl. binary	read/write/program	Output quiescent voltage
SENSITIVITY	4	14	signed binary	read/write/program	
MODE	5	10	binary	read/write/program	Range, filter, output mode
LOCKR	6	2	binary	read/write/program	Lock Bit
A/D READOUT	7	14	two's compl. binary	read	
GP REGISTERS 1...3	8	3x13	binary	read/write/program	1)
D/A-READOUT	9	14	binary	read	Bit sequence is reversed during read
TC	11	10	binary	read/write/program	bits 0 to 2 TCSQ bits 3 to 7 TC bits 8 to 9 TC Range
GP REGISTER 0	12	13	binary	read/write/program	1)
DEACTIVATE	15	12	binary	write	Deactivate the sensor

1) To read/write this register it is mandatory to read/write all GP register one after the other starting with GP0. In case of a writing the registers it is necessary to first write all registers followed by one store sequence at the end. Even if only GP0 should be changed all other GP registers must first be read and the read out data must be written again to these registers.

6.6. Programming Information

Table 6–4: Data formats

Register	Char	DAT3				DAT2				DAT1				DAT0			
	Bit	**15**	**14**	**13**	**12**	**11**	**10**	**09**	**08**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
CLAMP LOW	Write	–	–	–	–	–	–	–	–	V	V	V	V	V	V	V	V
	Read	–	–	V	V	V	V	V	V	V	V	–	–	–	–	–	–
CLAMP HIGH	Write	–	–	–	–	–	–	–	V	V	V	V	V	V	V	V	V
	Read	–	–	V	V	V	V	V	V	V	V	V	–	–	–	–	–
VOQ	Write	–	–	–	–	–	V	V	V	V	V	V	V	V	V	V	V
	Read	–	–	V	V	V	V	V	V	V	V	V	V	V	–	–	–
SENSITIVITY	Write	–	–	V	V	V	V	V	V	V	V	V	V	V	V	V	V
	Read	–	–	V	V	V	V	V	V	V	V	V	V	V	V	V	V
MODE	Write	–	–	–	–	–	–	V	V	V	V	V	V	V	V	V	V
	Read	–	–	V	V	V	V	V	V	V	V	V	V	–	–	–	–
LOCKR	Write	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	V
	Read	–	–	–	V	–	–	–	–	–	–	–	–	–	–	–	–
GP 1...3 Registers	Write	–	–	–	V	V	V	V	V	V	V	V	V	V	V	V	V
	Read	–	–	V	V	V	V	V	V	V	V	V	V	V	V	V	–
D/A-READOUT 1)	Read	–	–	V	V	V	V	V	V	V	V	V	V	V	V	V	V
TC	Write	–	–	–	–	–	–	V	V	V	V	V	V	V	V	V	V
	Read	–	–	V	V	V	V	V	V	V	V	V	V	–	–	–	–
GP 0 Register	Write	–	–	–	V	V	V	V	V	V	V	V	V	V	V	V	V
	Read	–	–	V	V	V	V	V	V	V	V	V	V	V	V	V	–
DEACTIVATE	Write	–	–	–	–	1	0	0	0	0	0	0	0	1	1	1	1

V: valid, –: ignore, bit order: MSB first 1) LSB first

If the content of any register (except the lock registers) is to be changed, the desired value must first be written into the corresponding RAM register. Before reading out the RAM register again, the register value must be permanently stored in the EEPROM.

Permanently storing a value in the EEPROM is done by first sending an ERASE command followed by sending a PROM command. **The address within the ERASE and PROM commands must be zero.** ERASE and PROM act on all registers in parallel.

If all HAL83x registers are to be changed, all writing commands can be sent one after the other, followed by sending one ERASE and PROM command at the end.

During all communication sequences, the customer has to check if the communication with the sensor was successful. This means that the acknowledge and the parity bits sent by the sensor have to be checked by the customer. If the Micronas programmer board is used, the customer has to check the error flags sent from the programmer board.

Note: For production and qualification tests it is mandatory to set the LOCK bit after final adjustment and programming of HAL83x. The LOCK function is active after the next power-up of the sensor.
The success of the lock process must be checked by reading at least one sensor register after locking and/or by an analog check of the sensors output signal.
Electrostatic discharges (ESD) may disturb the programming pulses. Please take precautions against ESD.

7. Data Sheet History

1. Advance Information: ”HAL 83x Robust Mutlti-Purpose Programmable Linear Hall-Effect Sensor Fam-ily”, Jan. 13, 2013, AI000169_001EN. First release of the Advance Information.

2. Preliminary Data Sheet: “HAL 83x Robust Multi-Pur-pose Programmable Linear Hall-Effect Sensor Fam-ily”, Aug. 2, 2013, PD000213_001EN. First release of the preliminary data sheet.
   Major Changes:

   – Absolute Maximum Ratings: Values for V_{ESD}

   – Characteristics: Values for V_{Offset}

3. Preliminary Data Sheet: “HAL 83x Robust Multi-Pur-pose Programmable Linear Hall-Effect Sensor Fam-ily”, Oct. 2, 2014, PD000213_002EN. Second release of the preliminary data sheet.
   Major Changes:

   – TO92 UT package drawing updated

   – TO92 UT package spread legs option deleted

   – Recommended operating conditions and characteristics:

     • Updated DNL value for HAL 835

     • Updated RL_{min} (load resistor)

   – Diagnostics and safety features updated

   – Offset correction feature for HAL 835 removed

4. Data Sheet: “HAL 83x Robust Multi-Purpose Programmable Linear Hall-Effect Sensor Family”, Feb. 25, 2015, DSH000169_001E. First release of the data sheet.
   Major Changes:

   – Step Response Times

5. Data Sheet: “HAL 83x Robust Multi-Purpose Programmable Linear Hall-Effect Sensor Family”, May 22, 2015, DSH000169_002E. Second release of the data sheet.
   Changes:

– Package TO92UT-1 (spread) added

– Package drawing TO92UT-2 (non-spread) updated

– Ammopack drawings updated

– Assembly and storage information

– Several text corrections

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