REPORT ON DELIVERABLE D2.4.2

DAIAD@feel prototype

PROJECT NUMBER: 619186
START DATE OF PROJECT: 01/03/2014
DURATION: 42 months

DAIAD is a research project funded by European Commission's 7th Framework Programme.

Dissemination Level	Public
Due Date of Deliverable	Month 40, 30/06/2017
Actual Submission Date	04/07/2017
Work Package	WP2 'Fixture-based Water Flow Generator
Task	Task 2.4
Type	Prototype
Approval Status	Submitted for Approval
Version	1.0
Number of Pages	52
Filename	D2.4.2_DAID@feel-prototype.pdf

Abstract

In this document, we present an overview of the prototype Deliverable D2.4.2 'DAIAD@feel prototypes', i.e., the updated and final version of DAIAD@feel prototypes constructed to be used for demonstrations, with integrated improvements derived from Trial feedback and our entire body of work in WP2.

History

version	date	reason	revised by
0.1	24/03/2017	Initial Version	Jonas Wirz
0.2	28/06/17	Revision	Jonas Wirz
0.3	29/06/2017	Revision	Thomas Stiefmeier
0.4	03/07/2017	Revision for submission	Jonas Wirz
0.5	04/07/2017	Final version	Thomas Stiefmeier
0.6	05/07/2017	Revision of final version	Jonas Wirz

Author List

organization	name	contact information
AMPHIRO	Jonas Wirz	wirz@amphiro.com
AMPHIRO	Thomas Stiefmeier	stiefmeier@amphiro.com

Executive Summary

In this document, we present an overview of the prototype Deliverable D2.4.2 'DAIAD@feel prototypes', i.e., the updated and final version of DAIAD@feel prototypes constructed to be used for demonstrations, with integrated improvements derived from Trial feedback and our entire body of work in WP2. We present the three different DAIAD@feel prototypes (LCD only, LCD and RF, RF only) and point out the main challenges faced during their development. Two out of three DAIAD@feel prototypes are commercially available named "amphiro a1 basic" and "amphiro b1 connect". The "amphiro a1 basic" has no RF-capabilities and outputs the measured volume and temperature on a LC-display. The "amphiro b1 connect" (DAIAD@feel prototype), by contrast, includes a RF-interface, which allows transfer of data from the device to a mobile application using BLE. Finally, the third prototype is targeted towards OEM integrations in third-party products.

The micro generator in the DAIAD@feel prototype allows energy autarkic usage of the device without any batteries. The generator is used to harvest energy as well as for measuring the volume flowing through the generator. This raises large challenges, which were successfully addressed during the development of the DAIAD@feel prototype such as: (a) changing generator load due to variable current consumption of the electrical circuitry imposes volume measurement inaccuracies, (b) production tolerances make every single DAIAD@feel prototype individual with respect to its frequency-flow rate relation, (c) dynamic elements to reduce pressure drop at high flow rates add a non-linear relation for frequency to flow rate conversion. All above drawbacks of the dual usage of the micro-turbine have been compensated by specially developed firmware of the DAIAD@feel prototype.

A newly designed, digitally controlled test system based on a gear-type pump minimized the influence of an operator onto measurements and lead to an increase in volume measurement accuracy from ±20% for the first DAIAD@feel prototype down to ±2% for the latest DAIAD@feel prototype. For commercialization of the DAIAD@feel prototype and to be allowed to sell the product in the EU market, product testing for CE conformity was obtained. Further, the DAIAD@feel prototype fully complies with drinking water directives such as DVGW (Deutscher Verein des Gas- und Wasserfachs) and KTW (Leitlinie zur hygienischen Beurteilung von organischen Materialien im Kontakt mit Trinkwasser (KTW-Leitlinie), 2013/470/D). Finally, the package (*i.e., the banderole*), was changed to provide more information to the end customer and adjust the design to current layout standards.

Abbreviations and Acronyms

ASQ	After Scenario Questionnaire
CSUQ	Computer System Usability Questionnaire
DUT	Device under Test
ECI	Energy Consumption Indicator
ECOI	Energy Consumption Information System
GUI	Graphical User Interface
HCI	Human-Computer-Interaction
ICT	Information and Communication Technologies
IS	Information System(s)
IHD	In-Home Display
IoT	Internet of Things
kWh	Kilowatt-hours
l/lt.	liters
m^3	Cubic meters
PSSUQ	Post-Study System Usability Questionnaire
QUIS	Questionnaire for User Interface Satisfaction
SUS	System Usability Scale
UI	User Interface
UMUX	Usability Metric for User Experience

Table of Contents

1. Introduction

The DAIAD@feel prototype consists of a micro-turbine harvesting energy from the water flow and measuring the volume flowing through the turbine. Together with a temperature sensor, the total heat energy used for a shower extraction can be displayed on a dedicated liquid crystal display (LCD). Further, an RF interface is available for communication using Bluetooth Low Energy (BLE).

The DAIAD@feel prototype is solely powered by the energy harvested from the water flowing through the micro generator. The micro generator is used for two purposes at the same time: energy harvesting and volume measurement. This imposes the following problems:

1) The rotational frequency of the micro generator is *reduced* with increasing electrical load (principle of energy conservation)
2) With increasing electrical load and increasing flow rate, the *pressure drop* across the device increases
3) A dynamic bypass adds a highly *non-linear* relation between flow rate and rotational generator frequency.

The first problem is well known in electrical grid supply where it is used to match the demand-side; the rotational frequency is directly proportional to the power available from the generator. For the DAIAD@feel prototype, the source (*i.e., the rotational frequency*) cannot be controlled, since the user might select different flow rates or even turn off the running water at any time. Therefore, the energy source is considered as *stochastic* and the changing load and rotational frequency need to be compensated algorithmically in software.

The second problem is addressed by adding a dynamical component to the generator, which opens a bypass to the actual turbine when the flow rate increases. This however, imposes problems for the volume measurement, since the relation between flow rate and generator frequency is not linear anymore. To compensate for this non-linearity, algorithms based on statistical measurements and factory calibration of every individual device is necessary.

This document will focus on three different versions of the DAIAD@feel prototype:

1) DAIAD@feel prototype with display only
2) DAIAD@feel prototype with display and RF-capabilities
3) DAIAD@feel prototype with RF capabilities only

This document not only includes technical aspects, but also provides an overview over the whole product and how it is presented to the end user.

2. DAIAD@feel prototypes

We have developed the following three (3) final versions of the DAIAD@feel prototypes. All three prototypes integrate the same facilities for measuring the volume and the temperature of the water flow. However, each one provides a different packaging option regarding the LCD and RF capabilities, thus supporting different user requirements. Specifically, the three versions are:

1) DAIAD@feel prototype with display but no RF-capabilities (*this is essentially a significantly improved version of the amphiro a1, integrating all advances introduced during the project except for the integrated BLE*);
2) DAIAD@feel prototype with display and RF-capabilities (*this is the final version which was extensively evaluated in the context of our real-world trials*);
3) DAIAD@feel prototype with RF-capabilities only (*this prototype integrates only the micro-generator with the BLE connectivity, allowing OEM applications*)

Prototype	Volume/Temperature Measurement	Display	RF-capabilities
1	X	X	
2	X	X	X
3	X		X

Table 1: Overview DAIAD@feel prototype features

2.1. DAIAD@feel prototype with Display

The DAIAD@feel prototype with display is Amphiro's commercially available product called amphiro a1 basic. This device measures the shower volume and the temperature and displays these quantities on the integrated LCD. The amphiro a1 basic was the starting point for the development of the DAIAD@feel prototype with RF-capabilities, which was used in all DAIAD trials.

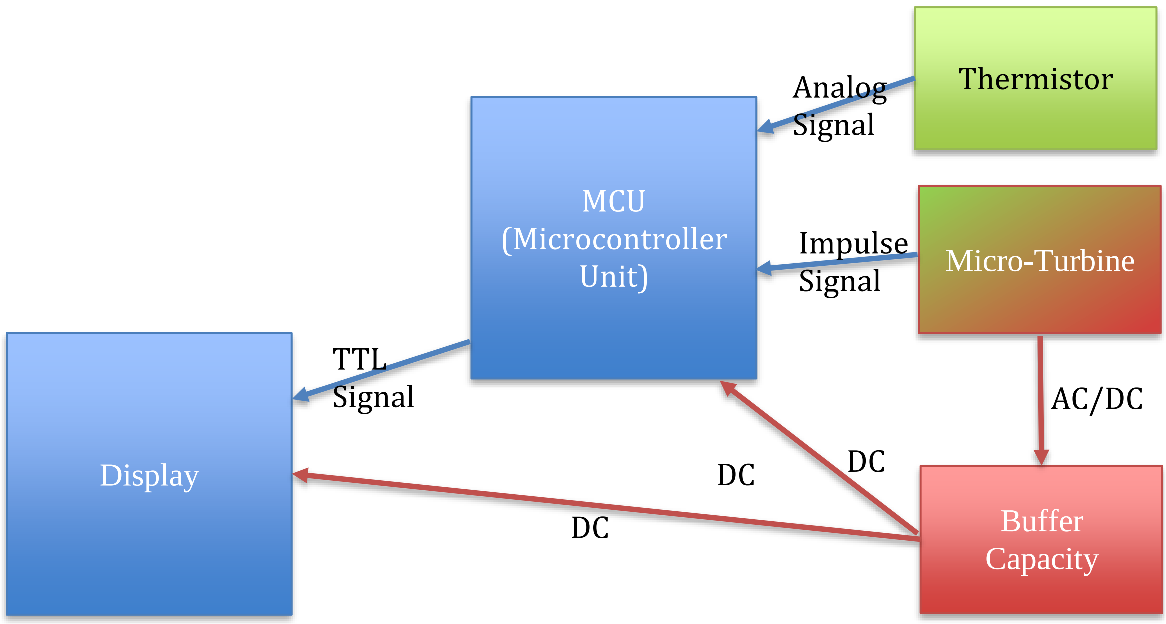


Figure 1: System overview of the DAIAD@feel prototype without RF-capabilities.

The electronics concept of the first DAIAD@feel prototype version is shown in Figure 1. All electronic parts can be assigned one of the following groups:

1) Sensors (green)
2) Power electronics (red)
3) Userinterface/Logic controllers (blue)

A microcontroller unit (MCU) is the core component of the system. It is connected to all other components and is programmed to process frequency measurements from the micro-turbine, temperature measurements from the thermistor and provides the processed information to the user by means of a customized LC display. The power electronics are necessary to produce a stabilized voltage and therefore ensure safe and continuous operation of the DAIAD@feel prototype. The power electronics consist of a AC/DC converter, a buffer capacity and a DC/DC converter, which is directly connected to the user interface and the logic controller. The DAIAD@feel prototype is equipped with two sensors: A thermistor for temperature measurement and a micro-turbine for flow rate measurement and energy harvesting.

Figure 2: DAIAD@feel prototype with display only. The product is commercially available named "amphiro a1 basic"

2.2. DAIAD@feel prototype with RF-capabilities

The DAIAD@feel prototype with RF-capabilities is an advanced development of the commercially available amphiro a1 basic. Coping with several challenges was necessary to add RF-capabilities:

1) Optimization of the micro-turbine to be able to harvest enough energy for RF-capabilities. D2.1.1 and D2.2.2 deal with the optimization of the micro-turbine and concludes with a redesigned coil, a redesigned bypass, a redesign of bearings to reduce friction and optimized power electronics.

2) Choosing an appropriate RF-standard. D2.3.1 and D2.3.2 evaluates different RF-standards currently available on the market. Such RF-standards are GSM, BLE, WLAN, M-Bus, ZigBee and LoRa. Due to the requirements of low-power, medium data throughput and high transmission range and market-share, BLE (Bluetooth Low Energy) was chosen as the RF-standard used in the DAIAD@feel prototype.

3) Redesign of the electronics (namely PCB). D2.4.1 introduces the newly designed PCB and its main components.

4) Rework of the calibration and new precision analysis. D2.2.1 and D2.2.2 cope with this rework and show the necessary steps.

5) Rework of mass production testing and quality insurance processes during manufacturing of the DAIAD@feel prototype. These changes are described in D2.4.1

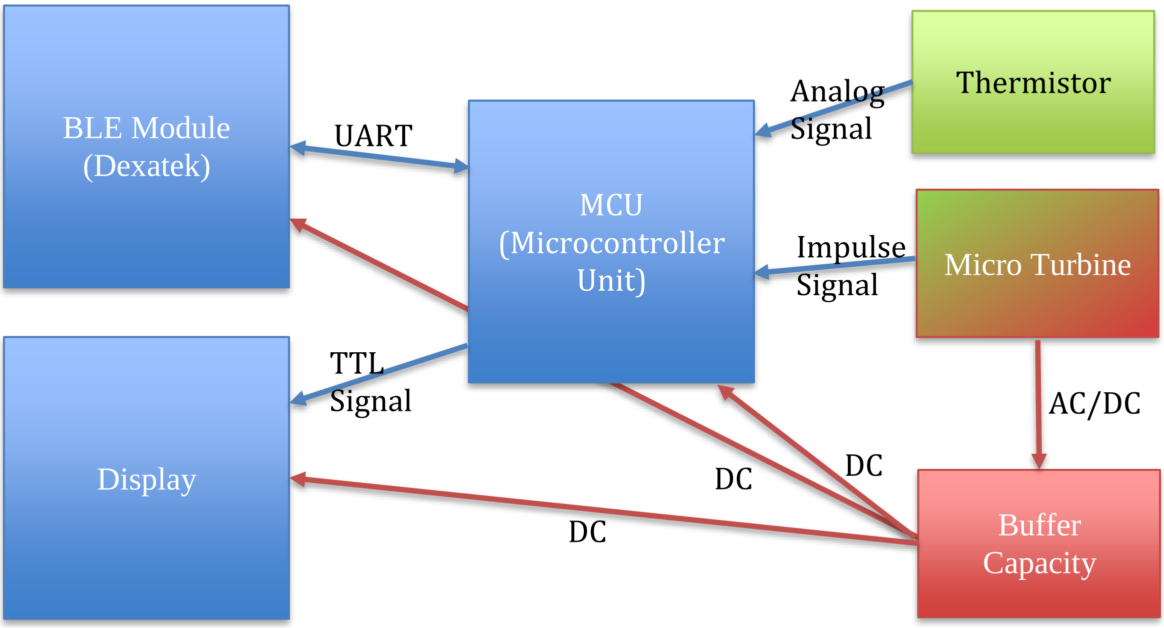


Figure 3: System overview of the DAIAD@feel prototype with display and RF-capabilities

Figure 4: DAIAD@feel prototype with Display and RF-capabilities. The product is commercially available and introduced into the market as "amphiro b1 connect".

2.3. DAIAD@feel prototype without display

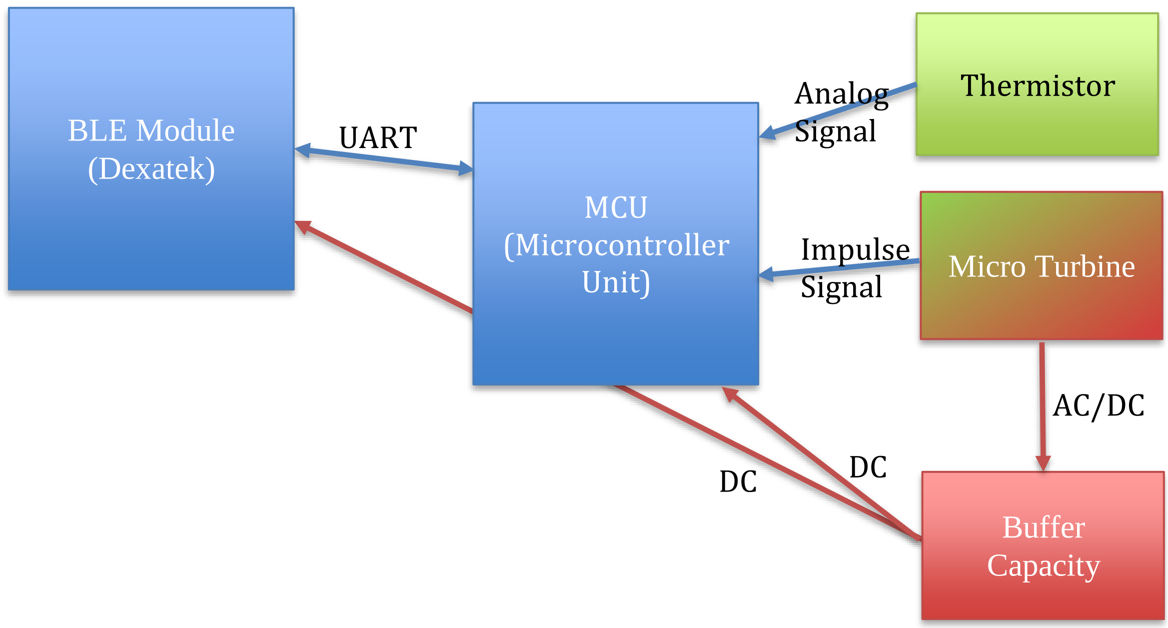


Figure 5: System overview of the DAIAD@feel prototype without display

The third version of the DAIAD@feel prototype has no display, which requires an alternative approach to pairing it with a smartphone, since the code cannot be shown on the display. Therefore, this prototype comes with a *predefined pairing* code which reduces data security.

2.4. Mechanical Design

The mechanical design of the DAIAD@feel prototype includes two main parts:

1) The micro-turbine used for energy harvesting and volume measurement
2) The housing, which holds the micro-turbine and the electronics

2.4.1. Micro-Turbine

The micro-turbine is a complex structure that harvests energy from the water-flow and can be used to measure the flow rate of the water flowing through the turbine. All parts of the turbine are designed such that they can be produced using injection molding. Further, optimization is done to compensate for production tolerances and ease of assembly during mass production.

Figure 6: Assembly of the micro-turbine

Figure 6 shows the drawing for assembly of the micro-turbine. The turbine itself is encapsulated in a turbine-tube (M9.2.1), which can withstand water pressure of up to 10 bar. The tube is closed by the adapter (M9.3.1), which is sealed to the tube with a special gasket that can compensate for production tolerances. The turbine includes a permanent magnet, which is rotated by the water flow.

2.4.1.1. Bypass Membrane

The bypass membrane as shown in Figure 6 (M9.2.10) is a rubber structure, which is bent by increasing water pressure and opens a bypass for the water flow. Through the bypass, water can flow beside the turbine and therefore not being used for rotating the turbine wheel and therefore not accounting for energy harvesting. The dynamic bypass reduces the amount of water flowing through the turbine and therefore decreases the efficiency of the micro-turbine, however it is necessary for reducing the pressure drop across the turbine at higher flow rates.

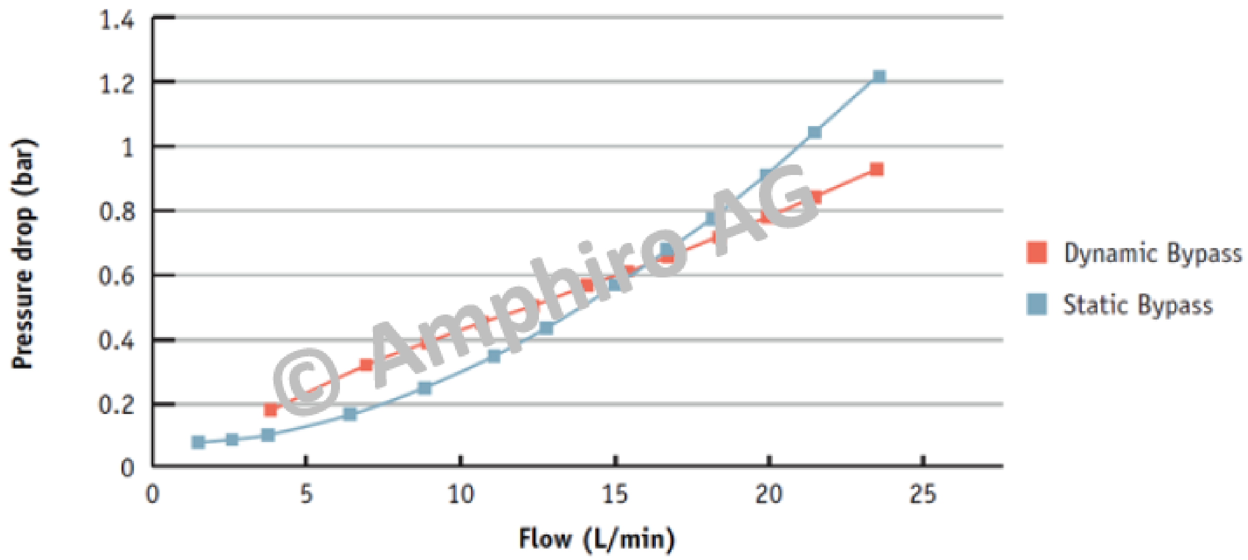


Figure 7: Comparison of pressure drop for a static and a dynamic bypass

Figure 7 shows the relation between pressure drop and flow rate for a dynamic and static bypass. By a static bypass, we refer to a bypass structure that does not change its shape with varying pressure. This means that independent of flow rate, the same relative amount of water can bypass the turbine. Deliverable 2.1.2 deals with the evaluation of different static bypasses and concludes that a static bypass is feasible in the sense of measurement precision and pressure drop, but reduces the operational range of the DAIAD@feel prototype to a very narrow flow rate region. The measured generator frequency at constant flow rate decreases with increasing bypass area, since an increased bypass area increases the amount of water bypassing the turbine and is therefore not used for energy harvesting.

In general, three factors need to be carefully balanced when designing a micro-turbine with a static bypass:

1) Pressure-drop: The pressure drop across the turbine must be as low as possible to not negatively impact the user experience.

2) The generator frequency should never be lower than 30Hz for a chosen flow rate region. Below 30Hz, not enough energy is harvested to power the electronics of the DAIAD@feel prototype.

3) The maximum frequency for the chosen flow rate region should be always smaller than 250Hz, since this is the maximum frequency the electrical circuitry is designed for. Further, the steady-state frequency of the micro-turbine should be as close as possible to 120Hz, which is the optimal frequency, the circuitry is designed for.

As can be seen from Figure 7, the pressure drop shows a higher slope at higher flow rates, which means that the pressure drop significantly increases at higher flow rates. This has a large impact on the user experience.

The dynamic bypass, by contrast, shows an approximately linear relation between the pressure drop and the flow rate as can be seen from Figure 7. Especially, at higher flow rates, the pressure drop across the micro-turbine is lower than for a static bypass. Further, the dynamic bypass ensures 30Hz generator frequency starting at very low flow rates (allows to power the electronics at low flow rates) and decreases the maximum frequency at higher flow rates, which reduces the risk of mechanical damage to the turbine. Due to its linear relation between flow rate and pressure drop, the dynamic bypass can be used over a wider range of flow rates and therefore maximizes the user experience with respect to pressure drop.

2.4.1.2. Coil

The copper coil (M9.4.4 in Figure 6) consists of N windings, which are wound around the turbine tube. According to Faraday's law, an electrical voltage is induced in the copper coil with N windings, if the magnetic field $\boldsymbol{\phi}$ inside said coil changes over time t:

$$\boldsymbol{V(t) = -N \cdot \frac{\partial \phi}{\partial t}}$$

The fundamental formula $\boldsymbol{P = U \cdot I}$ (P=power, U=voltage, I=current) states that, in order to actually use electrical energy from this structure, one needs to draw a current. However, this current runs through the generator coil and induces a magnetic field. The induced magnetic field is counter acting the permanent magnet's magnetic moment $\vec{\boldsymbol{m}}$, which results in a force $\boldsymbol{F}$ that counter acts the water's force on the wheel. Because the flowing water works against this force by rotating the wheel and displacing it by the distance $\boldsymbol{s}$, work is done: $\boldsymbol{W = F \cdot s}$. This work can be used to harvest energy from the structure, which can be used to power the DAIAD@feel prototype's electronics.

The selection of appropriate parameters for the coil is described in detail in deliverable D2.1.1.

2.4.2. Housing

The housing of the DAIAD@feel prototype is made from two separate plastic parts. The front part is partly transparent to allow the user to see the display. The back part provides openings for the micro-turbine and covers the enclosed electronics. A DAIAD@feel prototype mounted to a shower-head is shown in Figure 8.

All plastic parts are produced by injection molding, which is a cost-effective way of producing plastic parts. However, the injection molding process sometimes shows huge tolerances in dimension, which requires a careful industrial design to cope with tolerance chains of several plastic parts playing together.

For the DAIAD@feel prototype this becomes particularly critical for the front-window, where two different materials are used to form the transparent part. These two materials show different thermal expansion coefficients and therefore lead to tension when cooling, which tends to give the front window a curved shape and must be considered and compensated when parametrizing the molding process and the eventual assembly of the parts.

Figure 8 DAIAD@feel prototype mounted in a shower.

2.4.3. Display

The DAIAD@feel prototype includes a liquid crystal display (LCD), which can be used to provide visual feedback to the user. The content of the display is fixed to a predefined and so-called display mask. This display mask consists of 112 segments, which can either be turned on or off individually. If a segment is turned on, it becomes black. If it is turned off, it gets invisible.

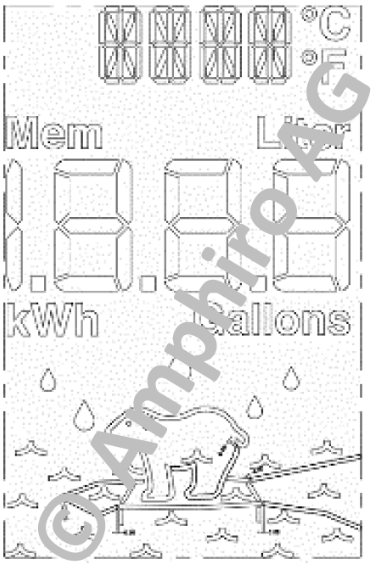


Figure 9: Display mask of the DAIAD@feel prototype

Figure 9 shows the display mask as used for the DAIAD@feel prototype. The display can be split into three distinct regions.

1) Top-region: The top-region consists of four 16-segment digits together with the symbols “°C” and “°F”. The 16-segment digits can be used to display any letter “A, B, C,…Z”, a number in the range of 1-9999 or a special symbol such as “-,/,+”. Further, the symbols “°C” or “°F” can be enabled independently.

In default configuration, the top-region of the display shows an efficiency measure alternating with the water temperature.

2) Middle-region: The middle-region of the display includes three full 7-segment digits, three decimal points and the symbol “1” in 7-segment design. Further, the symbols “Mem”, “Liter”, “kWh” and “Gallons” can be enabled.

During normal operation, the middle part of the display shows the water volume in Liters when water is flowing and the energy and the used water volume respectively when the water is not flowing.

3) Bottom-region: In the bottom region, an energy dependent animation of a bear on an ice-block is shown. The ice melts the more energy is used during a shower. At last, the ice melts completely and the bear falls into the water.

The display is controlled by the micro controller and the content can partly be configured using special BLE-commands.

3. Engineering Tradeoffs

3.1. Problem Definition

The DAIAD@feel prototype uses one single structure for harvesting energy and measuring the water flow through the turbine. This raises the following problem:

- Flow-measurement is influenced by changing load on the energy harvesting
- Non-linear relation between flow rate and frequency of energy harvester
- Production-tolerances due to EPDM and molded plastic parts.

3.2. Approaches

3.2.1. Test System

The basis for facing the challenges mentioned above is a precise and accurate test system, which is capable of applying a water flow with constant flow rate to the DAIAD@feel prototype. A first prototype version of such a system can be seen in Figure 10. The system was based on a centrifugal pump, which pumped water from a reservoir through the device and back into the reservoir. A bypass with variable opening was added to control the flow rate using two manual valves (opening the bypass reduces the flow rate through the DAIAD@feel prototype). However, a centrifugal pump is not volumetric, which means that one turn of the pump not necessarily equals the same amount of water pumped through the pump under variable load conditions. Therefore, pressure drop caused by the DAIAD@feel prototype can easily change the flow rate through the pump and therefore heavily influence the measurement ending in a non-constant flow rate through the DAIAD@feel prototype.

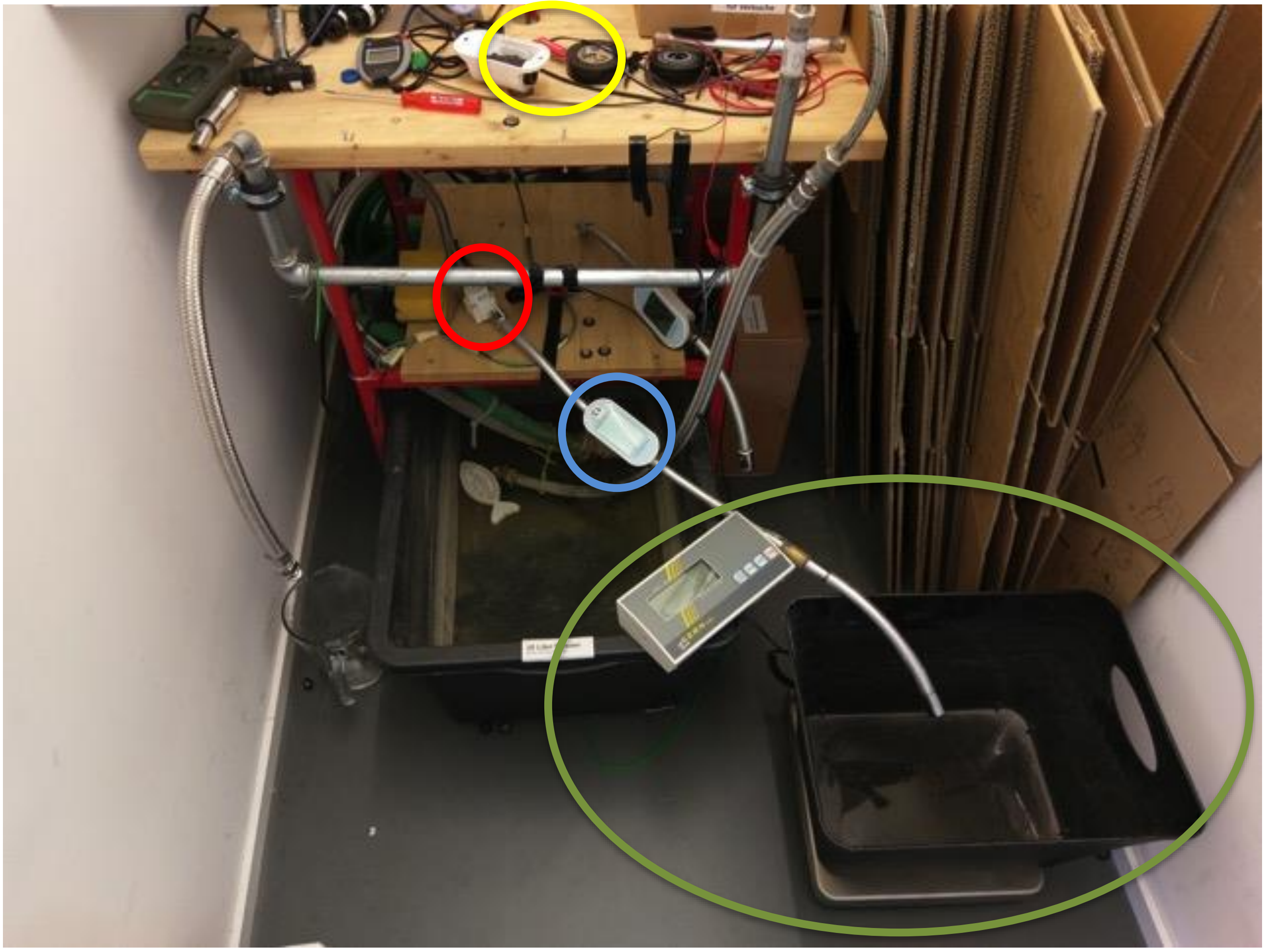


Figure 10: Test system with centrifugal pump. Two valves (yellow) are used to control the amount of water flowing through the DUT (blue). A Digmesa-Flowmeter (red) is used to measure the flow rate. A high precision scale (green) can further be used for accuracy measurements.

To overcome the problems mentioned above, the centrifugal pump was replaced by a gear-type pump. A gear-type pump is volumetric, which means that the same amount of water is pumped in every turn of the pump's motor. This makes the pumped volume independent of the pressure drop caused by the DAIAD@feel prototype.

The newly developed test system with the volumetric pump also features fully automatic measurements. The pump is connected to an inverter, which allows to control the frequency of the motor and therefore allows to select the flow rate produced by the pump. The inverter is connected to a linux based computer through an RS485 interface, which enables digital control of the frequency of the pump.

Since the pump frequency and therefore the flow rate can be digitally controlled, the influence of the operator can be eliminated, which reduces measurement errors significantly. Further, special shower profiles with different flow rates and pause times can be programmed in an xml-file. Once transferred to the test system, the time-based flow rate profile as defined in the xml-file is executed and applied to the DUT.

The system includes two differential pressure sensors which can be used to measure the differential pressure across the DUT or the inlet and outlet of the pump.

The new test system is shown in Figure 11 and Figure 12. The system is mounted onto a metal construction equipped with wheels such that it can be used wherever it is needed. Figure 11 gives an overview of the new test system, which is 760x760x820mm (length x width x height) in size. The touchscreen (yellow) controls all functions of the system and shows key parameters such as pressure measurements and flow rate measurements (refer to Figure 13 for more details of the GUI). The DUT (red) is connected to the system by two hoses. One hose comes directly from the pump and the other one reverts the water into the reservoir. The emergency switch (green) is used to turn off the whole system in case of a technical problem.

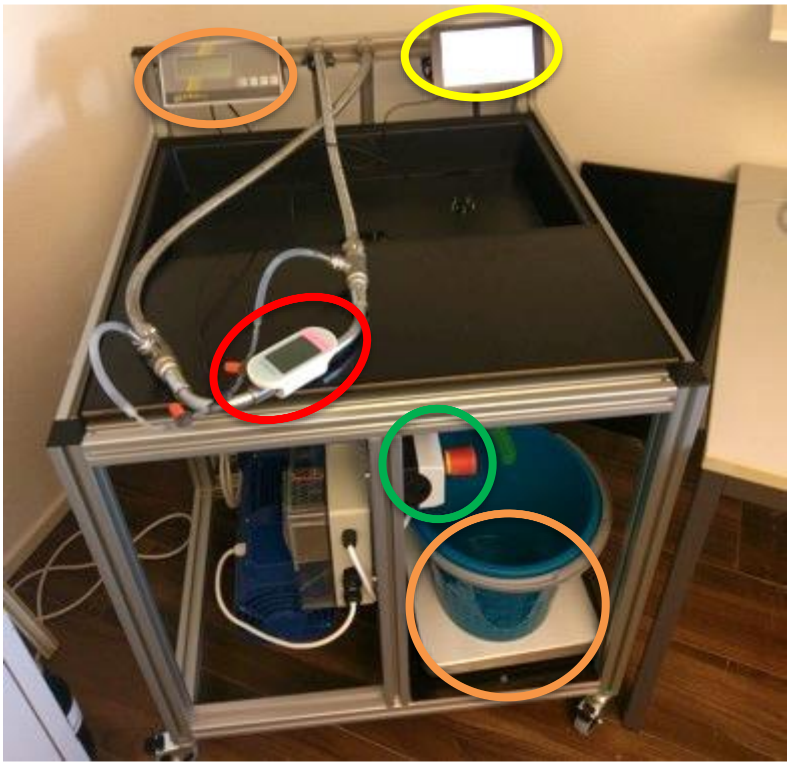


Figure 11: Front view of the newly developed test system. The touchscreen (yellow) is used to control the flow rate and valves of the test system. The emergency switch (green) can be used to deactivate the whole system in case of technical failure. The accuracy of the DUT (red) can be measured using a high precision scale (orange).

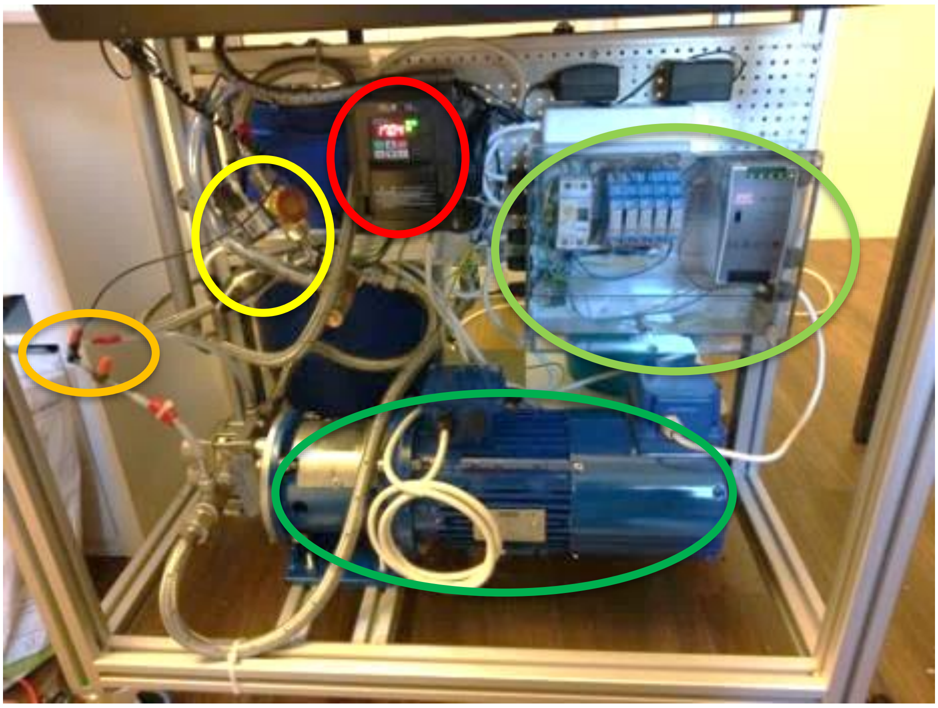


Figure 12: Side view of the newly developed test system. The gear-type pump (dark green) is controlled by the invertor (red). The magnetic valves (yellow) and the invertor (red) are switched on and off by relays mounted inside a waterproof case (light green). A pressure sensor (orange) constantly measures the pressure across the pump.

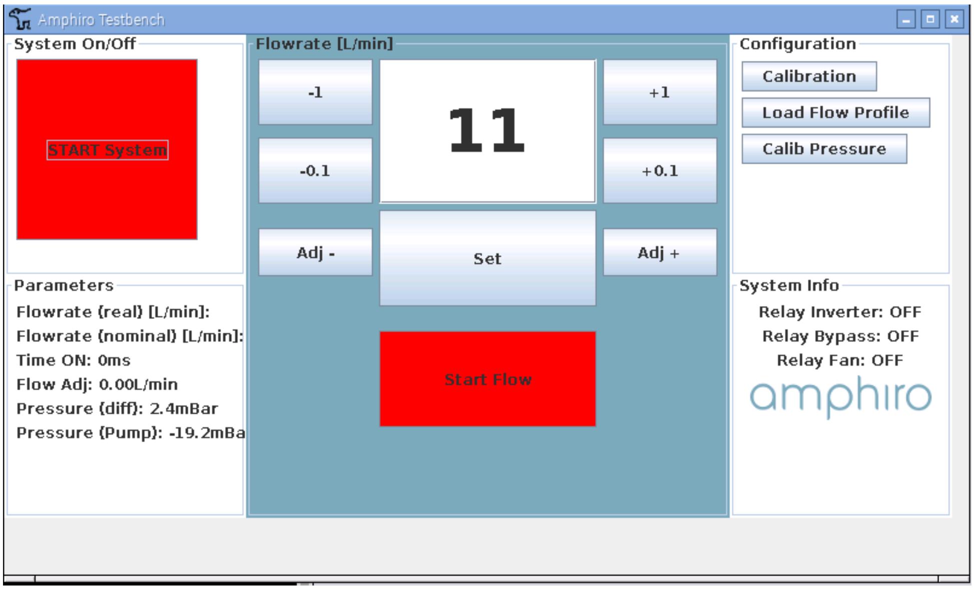


Figure 13: GUI (Graphical User Interface) of the newly developed test system. The whole system (namely the flow rate and the bypass) can be controlled through this interface. Further, key-parameters such as pressure drops and flow rate are logged and displayed.

3.2.2. Changing generator load

The DAIAD@feel prototype uses one single micro generator for energy harvesting and flow rate measurement. The flow rate measurement is based on the measured generator frequency. Under constant load conditions, this relation is linear and each frequency uniquely corresponds to one flow rate, which would allow to precisely measure the current flow rate through the generator.

However, in the application of the DAIAD@feel prototype, the generator load is not constant due to power bursts caused by the BLE-module (namely during advertisement of real time shower data). The fundamental principle of energy conservation therefore implies that the frequency of the generator decreases with increasing generator load. For the flow rate measurement, this implies that one frequency not uniquely corresponds to one flow rate, which makes it necessary to statistically measure the flow rate-frequency relation from several DAIAD@feel prototypes and use mathematical tools to find a relation, which is valid for all of the produced devices.

3.2.3. Non-linear relation between frequency and flow rate

Beside the changing load, a dynamic element made from EPDM controls the amount of water which flows through the turbine. This part lets more water bypass the turbine at high flow rates and forces more water to flow through the turbine at low flow rates. As a drawback, this adds further non-linearity to the relation between the frequency and flow rate.

As for the changing generator load, the effect can be partly compensated by obtaining measurements and find a mathematical model, which is statistically valid for all devices.

3.2.4. Production Tolerances

The production method for the micro generator of the DAIAD@feel prototype is injection molding. This is a standardized production method, which is not prohibitive and accurate enough for mass production. However, different thermal coefficients add small dimensional inaccuracies. These inaccuracies make every DAIAD@feel prototype unique with respect to its flow rate-frequency relation.

To account for this problem, every single DAIAD@feel prototype is calibrated after production using the calibration equipment as shown in Figure 18.

3.2.5. Calibration Flow rate

Due to manufacturing tolerances, each single DAIAD@feel prototype needs to be calibrated at the end of production. This is done using the calibration equipment as shown in Figure 18. During calibration, the device is exposed to water with a constant flow rate. Due to the one-point calibration, the device is supposed to be within specification of +-10% volume measurement error at the calibration flow rate. These calibration flow rate therefore needs to be as close as possible to the flow rate of an average household, where the DAIAD@feel prototype is used.

In first studies in Switzerland, the mean flow rate was near 12 L/min, which is why 12L/min was used as the calibration flow rate for the first DAIAD@feel prototypes (Figure 14). However, later study results and study results from Germany, Alicante and St Albans showed significant lower mean flow rates. This is why the current DAIAD@feel prototypes are calibrated at 11L/min.

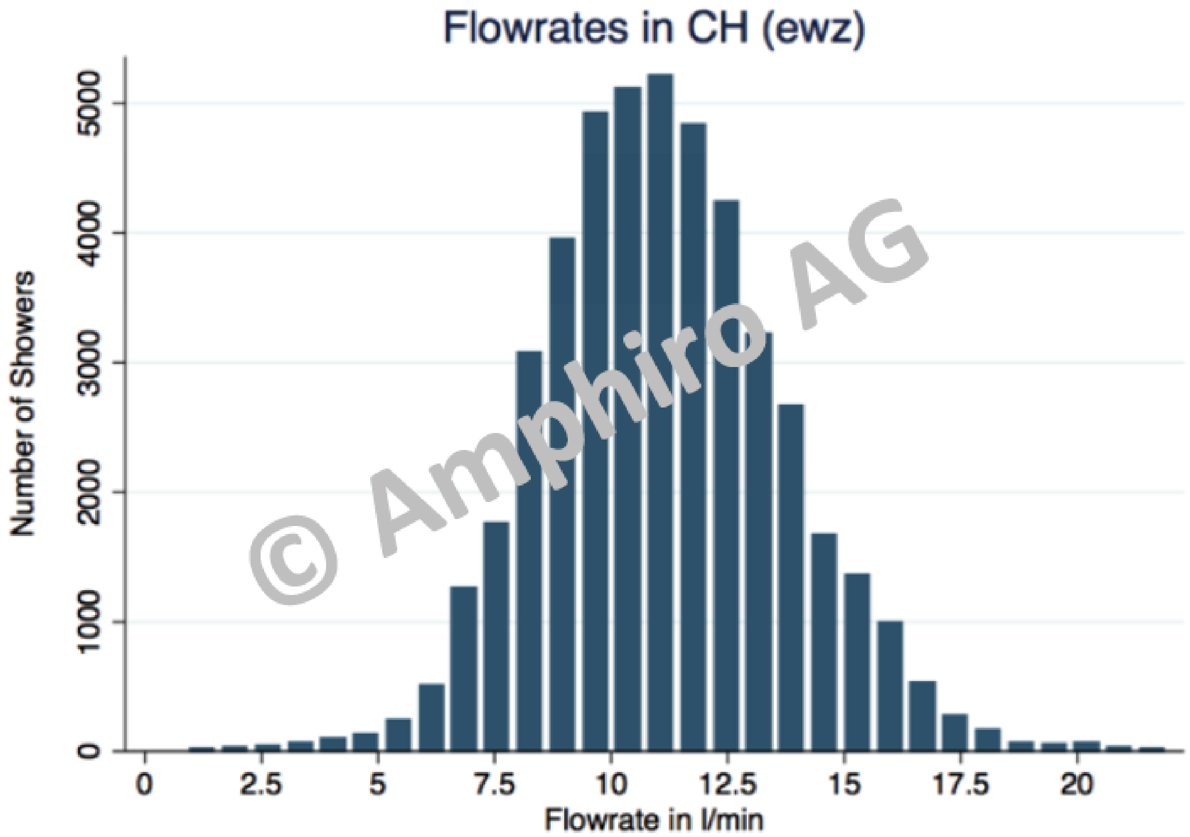


Figure 14: Flow rate histogram

4. Production

For the Trials, 300 DAIAD@feel prototypes (amphiro b1 connect) were required and produced for this purpose. So far, more than 20'000 amphiro b1 connect devices have been produced. The production of all DAIAD@feel prototypes was successfully carried out in the EU and the devices have been shipped to the trial locations.

4.1. Assembly

The assembly of the DAIAD@feel prototype includes 20 individual steps and is carried out by hand (no robots). The main steps include:

1) Programming and testing of the electronics (see section 4.2)
2) Assembly of the micro-turbine (several sub-steps)
3) Assembly of the front-housing including the display
4) Assembly of the rear-housing including the micro-turbine
5) Soldering the cables from thermistor and micro-turbine to the electronics and sealing of the contacts
6) Closing the DAIAD@feel prototype

The whole assembly is carried out by hand and one single person. The assembly includes wet-processes for properly sealing the product, which increase overall production costs, but also increase product quality and reliability.

4.2. Product Quality / Testing

To reach high product quality, the production process is designed to incorporate three different test procedures. In a first step, the printed circuit board (PCB) is mounted and soldered with the proper components; the microprocessor is then ready to be programmed. Note: the micro generator and the temperature sensor are not yet connected to the PCB. After the programming of the host

Figure 15 Sealing of soldering points with sealing adhesive.

microcontroller the first test is performed: A sinusoidal voltage is used to simulate a high-speed generator and a resistor is used to simulate the temperature sensor. The host microcontroller checks if the measured frequency of the simulated generator is as it is expected.

In parallel, the second test is started in the background: The BLE module starts announcing the unique ID of the host microcontroller over the air.

The first test is continued with a test of the LCD functionality: Four different screens are shown to the system operator with a characteristic display pattern. Each has to be confirmed by the operator. Once all screens are confirmed, the first test for functional electronics is successfully concluded.

Right after the first test is finished, the second test continues (in the background): the host microcontroller sends its unique ID via serial interface to the testing infrastructure where this information can be compared to the one that is being announced on the Bluetooth Low Energy channel. If the equality is successfully asserted, the second test is also passed and the smart meter is ready for the third test: the so-called product testing.

Figure 17 illustrates this production step and shows the “tester” used to ensure product quality.

In the third test the now fully assembled smart meter is operated with water at a fixed flow rate. This way, each device is tested for successful operation and in addition can be calibrated as described in DAIAD deliverable D2.2.1. Special test equipment, as depicted in Figure 17 and 18, was developed and shipped to the production site.

Figure 16: Flow chart of testing procedure in production

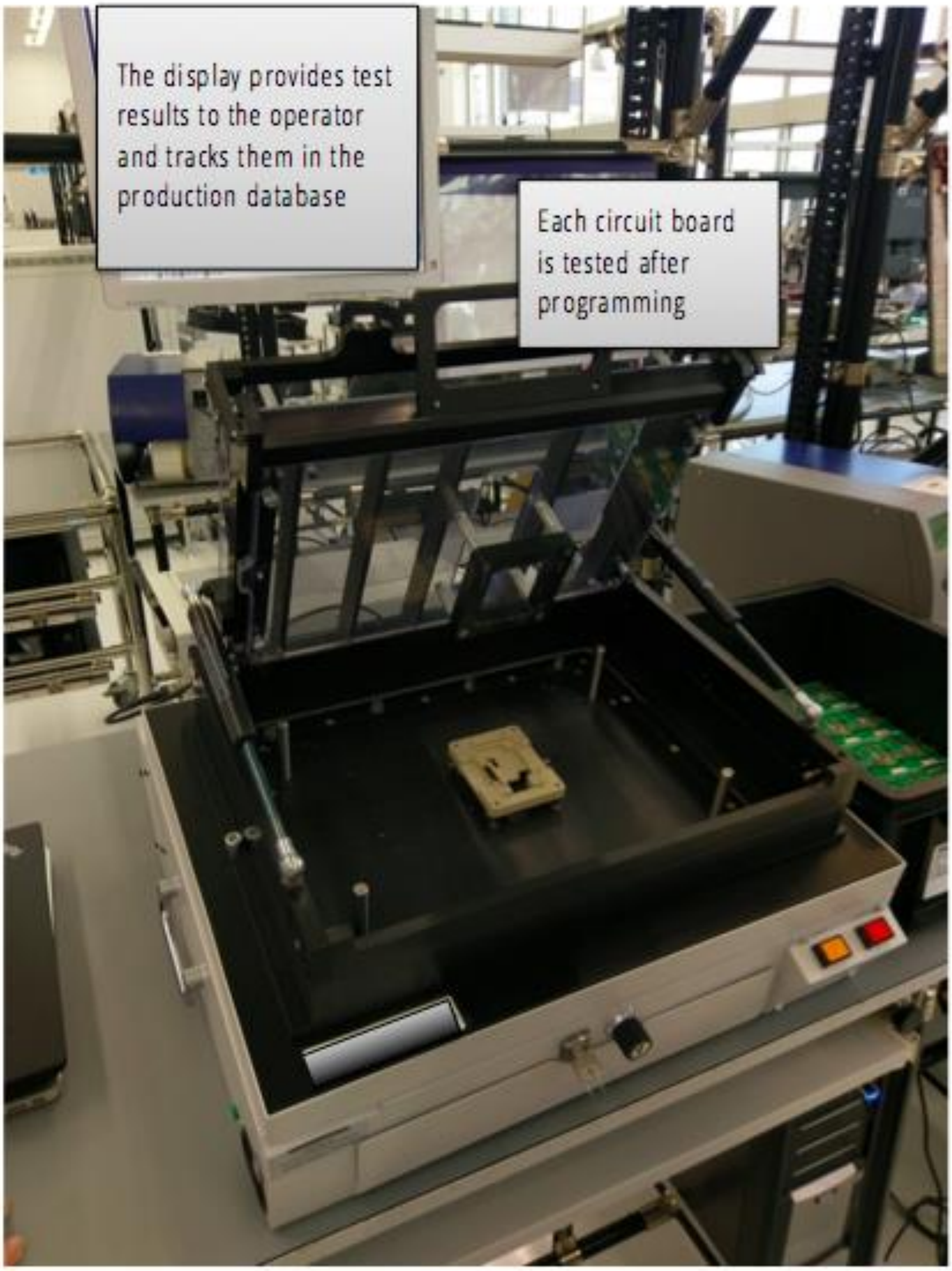


Figure 17: Tester for programming and testing of DAIAD@feel prototype electronics. The electronics are placed onto the white part in the middle of the machine. It then gets electrically connected from the bottom.

Figure 18: Calibration equipment at production site. The device is calibrated and tested with a water-flow similar to real water extractions.

5. Installation and Operation

The outer physical dimensions of the DAIAD@feel prototype are the same as the ones of the amphiro a1 basic product and the installation in the shower is essentially analog to the a1 installation and illustrated in Figure 19. The complete set of instructions included in the product's packaging is provided in the Annex.

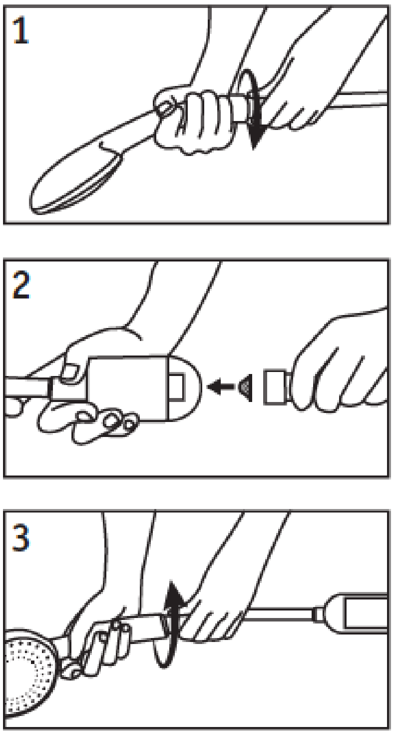


Figure 19: DAIAD@feel installation guide

6. Commercialization

6.1. Certificates

6.1.1. CE (Communauté Européenne)

Every product sold in the EU market must comply with CE regulations. In particular, the following regulations apply to the DAIAD@feel prototype:

- DIN EN 60950-1:2014
- DIN EN 55014-1:2012
- DIN EN 55014-2:2009
- ETSI EN 301 489-1 V1.9.2
- ETSI EN 301 489-17 V2.2.1
- ETSI EN 300 328 V1.8.1

The amphiro b1 connect device (DAIAD@feel prototype) was successfully tested for the above directives and therefore fully complies with CE regulations when used according to specification. The CE certificate for the amphiro b1 connect therefore allows to sell the product within the EU market.

6.1.2. Drinking Water approval

Components in contact with drinking water must have a drinking water approval. In Germany such a component must be certified according to DVGW-W270 and KTW. The standard describes a test, where the component is put into drinking water for several months. After predefined time intervals, the bio-film is removed from the probe and is analyzed with respect to composition. Limiting values of various bio-components are listed and restricted by DVGW-W270 regulation.

All components of the DAIAD@feel prototype in touch with drinking water are produced according to DVGW-W270 and KTW regulations.

6.2. Packaging

The packaging of the DAIAD@feel prototype consists of an inner package made from cardboard and a banderole placed on top of the inner package. This allows a high degree of flexibility with changing the banderole design without changing the whole package. The package can be seen in Figure 20.

Figure 20: DAIAD@feel prototype (amphiro b1 connect) packaging

During the development period of Task 2.4, the banderole has changed due to user feedback and changing marketing strategies. The old banderole is shown in Figure 21 and the new banderole is shown in Figure 22. The main changes are as follows:

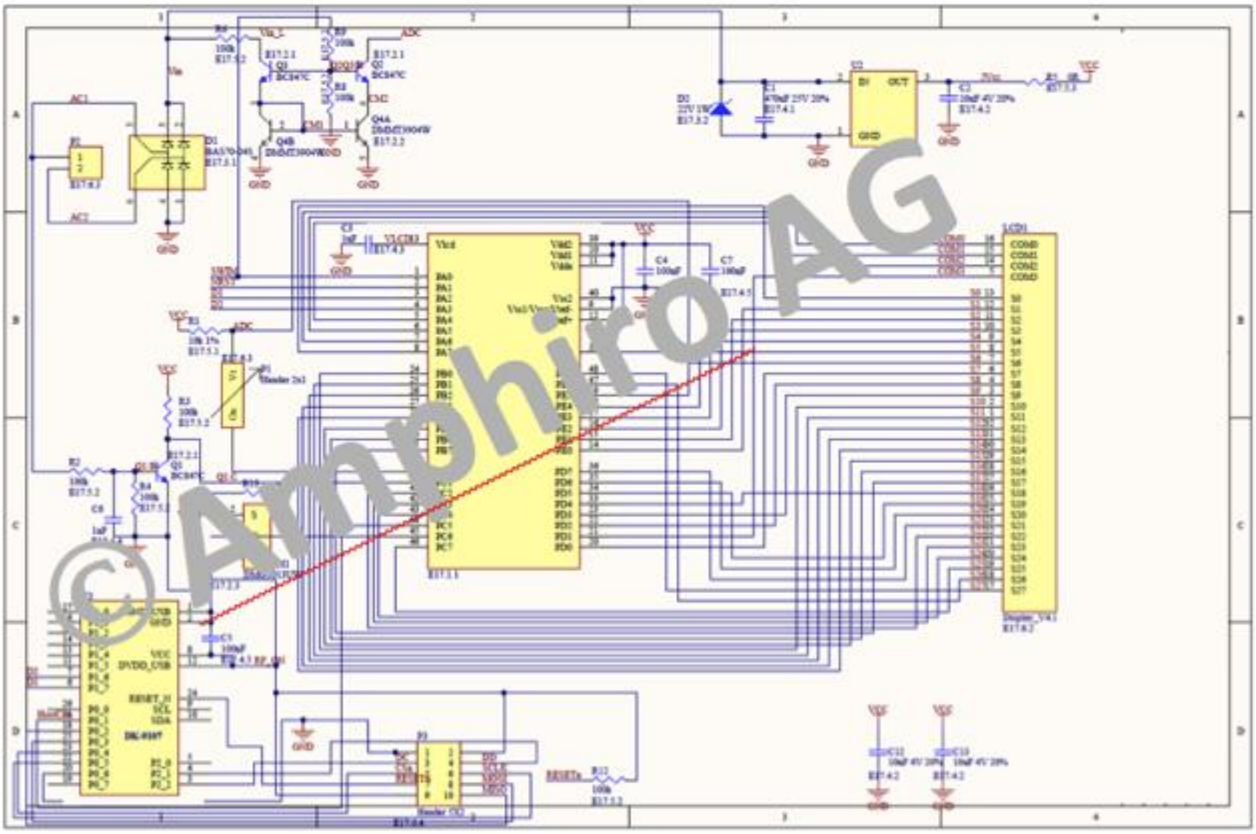
- Content: The content printed onto the banderole has changed to include more information for the potential customer.
- Material: The material has changed from blurry, white cart-board to UV gloss white cart-board.
- Printing technology: The printing technology has changed. This allows to use more colors and having printed photorealistic pictures onto the banderole.

Figure 21: Initial design of the banderole for the first few batches of amphiro b1 connect

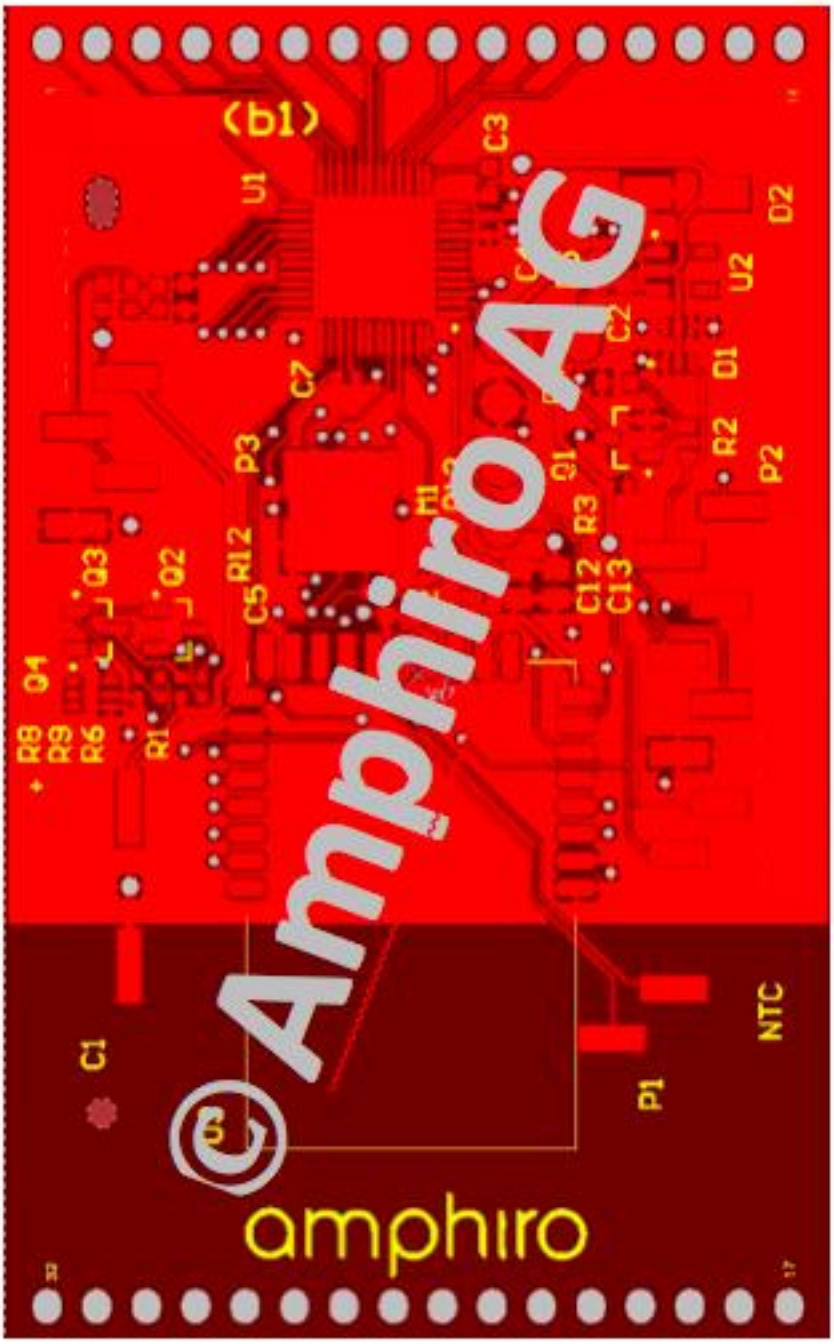
Figure 22: Re-designed banderole for the current batch of amphiro b1 connect

7. Appendix

7.1. Schematics



7.2. Board Layout (PCB)



7.3. Datasheet STM MCU

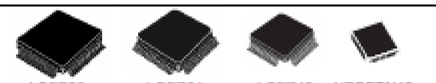
STM8L151x8 STM8L152x8
STM8L151R6 STM8L152R6

8-bit ultralow power MCU, up to 64 KB Flash + 2 KB data EEPROM, RTC, LCD, timers, USARTs, I2C, SPIs, ADC, DAC, comparators

Datasheet - production data

Features

- Operating conditions
  - Operating power supply: 1.65 to 3.6 V (without BOR), 1.8 to 3.6 V (with BOR)
  - Temp. range: -40 to 85, 105 or 125 °C
- Low power features
  - 5 low power modes: Wait, Low power run (5.9 µA), Low power wait (3 µA), Active-halt with full RTC (1.4 µA), Halt (400 nA)
  - Consumption: 200 µA/MHz+330 µA
  - Fast wake up from Halt mode (4.7 µs)
  - Ultra low leakage per I/0: 50 nA
- Advanced STM8 core
  - Harvard architecture and 3-stage pipeline
  - Max freq: 16 MHz, 16 CISC MIPS peak
  - Up to 40 external interrupt sources
- Reset and supply management
  - Low power, ultrasafe BOR reset with 5 programmable thresholds
  - Ultralow power POR/PDR
  - Programmable voltage detector (PVD)
- Clock management
  - 32 kHz and 1-16 MHz crystal oscillators
  - Internal 16 MHz factory-trimmed RC and 38 kHz low consumption RC
  - Clock security system
- Low power RTC
  - BCD calendar with alarm interrupt,
  - Digital calibration with +/- 0.5ppm accuracy
  - Advanced anti-tamper detection
- DMA
  - 4 ch. for ADC, DACs, SPIs, I^2C, USARTs, Timers, 1 ch. for memory-to-memory
- LCD: 8x40 or 4x44 w/ step-up converter
- 12-bit ADC up to 1 Msps/28 channels
  - Temp. sensor and internal ref. voltage



- Memories
  - Up to 64 KB of Flash memory with up to 2 KB of data EEPROM with ECC and RWW
  - Flexible write/read protection modes
  - Up to 4 KB of RAM
- 2x12-bit DAC (dual mode) with output buffer
- 2 ultralow power comparators
  - 1 with fixed threshold and 1 rail to rail
  - Wakeup capability
- Timers
  - Three 16-bit timers with 2 channels (IC, OC, PWM), quadrature encoder
  - One 16-bit advanced control timer with 3 channels, supporting motor control
  - One 8-bit timer with 7-bit prescaler
  - 1 Window and 1 independent watchdog
  - Beeper timer with 1, 2 or 4 kHz frequencies
- Communication interfaces
  - Two synchronous serial interface (SPI)
  - Fast I^2C 400 kHz SMBus and PMBus
  - Three USARTs (ISO 7816 interface + IrDA)
- Up to 67 I/Os, all mappable on interrupt vectors
- Up to 16 capacitive sensing channels supporting touchkey, proximity, linear touch and rotary touch sensors
- Fast on-chip programming and non-intrusive debugging with SWIM, Bootloader using USART
- 96-bit unique ID

Table 1. Device summary

Reference	Part number
STM8L151x8 STM8L152x8	STM8L151C8, STM8L152C8, STM8L151R8, STM8L152R8, STM8L151M8, STM8L152M8
STM8L151R6 STM8L152R6	STM8L151R6, STM8L152R6

July 2013 DocID17943 Rev 6 1/134

This is information on a product in full production. www.st.com

7.4. Datasheet BLE-Module

TEL: +886 2 86984245 FAX:+886 2 86984108
Add: 12F-6, NO.81, Sec.1, Hsin Tai Wu Rd., Xizhi Dist., New Taipei City , Taiwan.

Specifications

- **RF**

– 2.4-GHz *Bluetooth* low energy Compliant and Proprietary RF System-on-Chip

– Supports 250-kbps, 500-kbps, 1-Mbps, 2-Mbps Data Rates

– Excellent Link Budget, Enabling Long- Range Applications Without External Front Modes End

– Programmable Output Power up to 0 dBm

– Excellent Receiver Sensitivity (–94 dBm at 1 Mbps), Selectivity, and Blocking Performance

– Suitable for Systems Targeting Compliance With Worldwide Radio Frequency Regulations: ETSI EN 300 328 and EN 300 440 Class 2 (Europe), FCC CFR47 Part 15 (US) and ARIB STD-T66 (Japan)

- **Microcontroller**

– High-Performance and Low-Power 8051 Microcontroller Core With Code Prefetch

– In-System-Programmable Flash, 128- or 256-KB

– 8-KB RAM With Retention in All Power Modes

– Hardware Debug Support

– Extensive Baseband Automation, Including Auto-Acknowledgment and Address Decoding

– Retention of All Relevant Registers in All Power Modes

- **Low Power**

– Active-Mode RX Down to: 17.9 mA

– Active-Mode TX (0 dBm): 18.2 mA

– Power Mode 1 (4-µs Wake-Up): 270 µA

– Power Mode 2 (Sleep Timer On): 1 µA

– Power Mode 3 (External Interrupts): 0.5 µA

– Wide Supply-Voltage Range (2 V–3.6 V)

DEXATEK

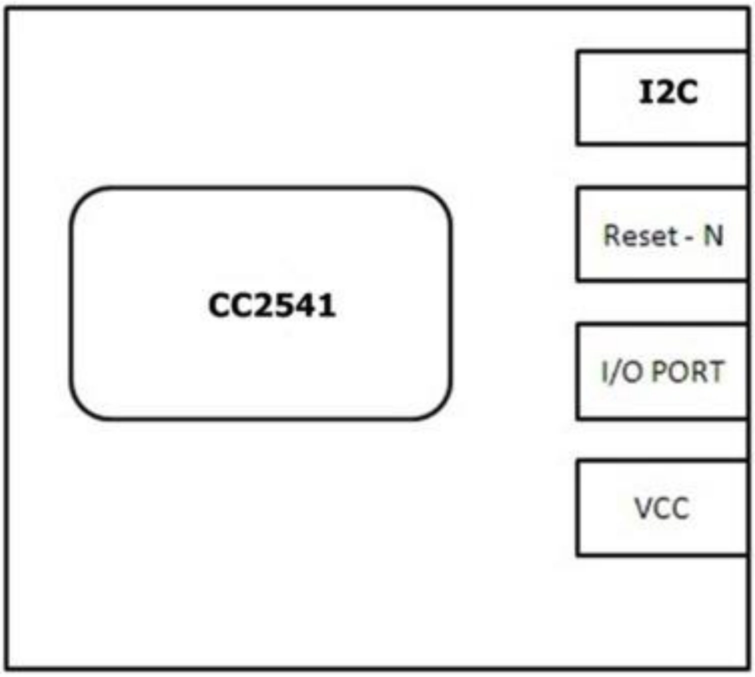
TEL: +886 2 86984245 FAX:+886 2 86984108
Add: 12F-6, NO.81, Sec.1, Hsin Tai Wu Rd., Xizhi Dist., New Taipei City , Taiwan.

Standard	Bluetooth low energy (BLE)
RF frequency range	Programmable in 2-MHz steps
RF data rate	1Mbps, GFSK, 250 kHz deviation
TX Current @ 0 dBm	18.2 mA
RX Current (normal gain)	17.9 mA
PM2 Current	0.9 uA
PM3 Current	0.4 uA
Max. output power	+0 dBm
Dimensions	25X17 mm
Operating temperature	-10~60℃
RF sensitivity	-Standard mode: typ. -87 dBm -High-gain mode: typ. -94 dBm
Output power	Typ. 0 dBm
Supply voltage	-0.3~3.9V

TEL: +886 2 86984245   FAX:+886 2 86984108
Add: 12F-6, NO.81, Sec.1, Hsin Tai Wu Rd., Xizhi Dist., New Taipei City , Taiwan.

Block Diagram

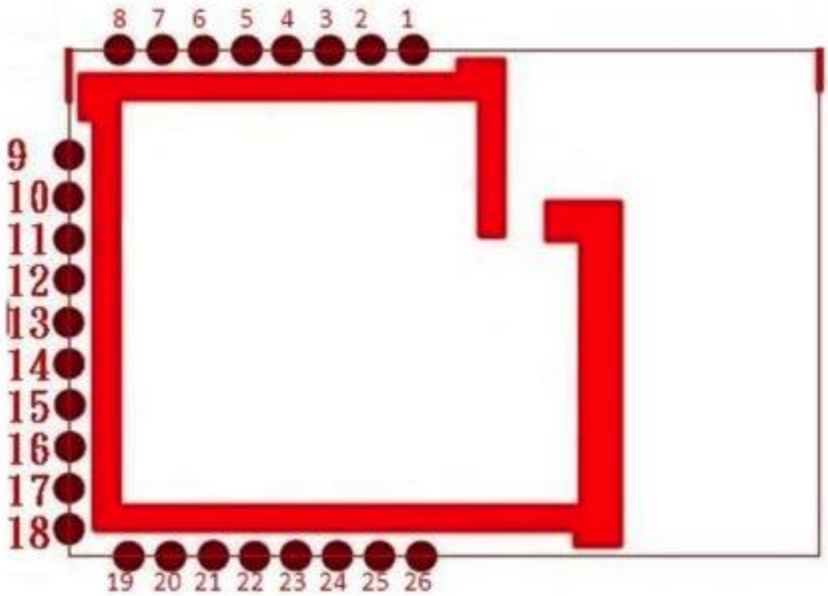
Block Diagram of DK9107 Module Board



DEXATEK TECHNOLOGY LTD.
TEL:+886 2 86984245   FAX:+886 2 86984108

TEL: +886 2 86984245 FAX:+886 2 86984108
Add: 12F-6, NO.81, Sec.1, Hsin Tai Wu Rd., Xizhi Dist., New Taipei City , Taiwan.

Pin Assignment



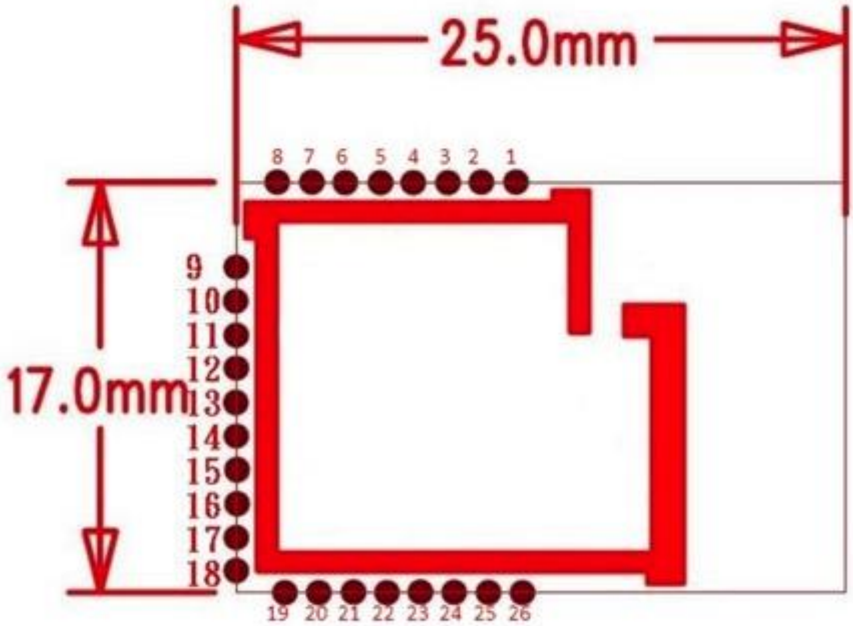
Pin	Name	Description
1	DGND_USB	Connect to GND
2	GND	Connect to GND
3	P2_2	DC(debug port)
4	P2_1	DD(debug port)
5	P2_0	Port 2.0
6	P1_7	Port 1.7
7	P1_6	Port 1.6
8	VCC	2-V–3.6-V analog power-supply connection
9	SCL	SCL

TEL: +886 2 86984245 FAX:+886 2 86984108
Add: 12F-6, NO.81, Sec.1, Hsin Tai Wu Rd., Xizhi Dist., New Taipei City , Taiwan.

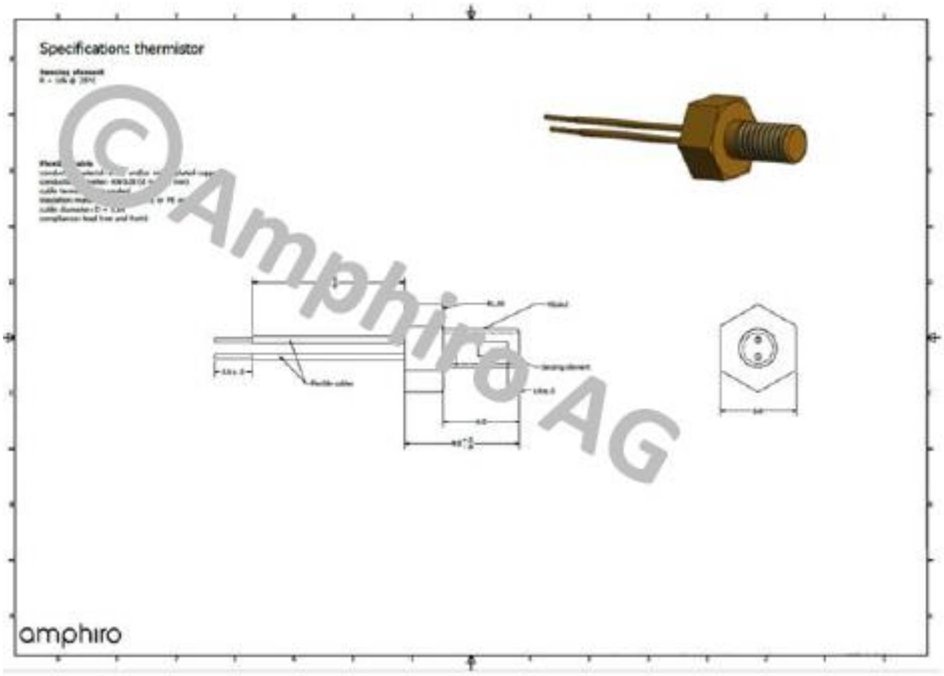
10	SDA	SDA
11	P1_5	Port 1.5
12	DVDD_USB	2-V–3.6-V digital power-supply connection
13	P1_4	Port 1.4
14	P1_3	Port 1.3
15	P1_2	Port 1.2
16	P1_1	LED+ (MAX 20mA)
17	P1_0	LED+ (MAX 20mA)
18	P0_2	Port 0.2
19	P0_7	Port 0.7
20	P0_6	Port 0.6
21	P0_1	Port 0.1
22	P0_5	Port 0.5
23	P0_4	Port 0.4
24	RESET_N	Reset, active-low
25	P0_3	Port 0.3
26	P0_0	Port 0.0

TEL: +886 2 86984245 FAX:+886 2 86984108
Add: 12F-6, NO.81, Sec.1, Hsin Tai Wu Rd., Xizhi Dist., New Taipei City , Taiwan.

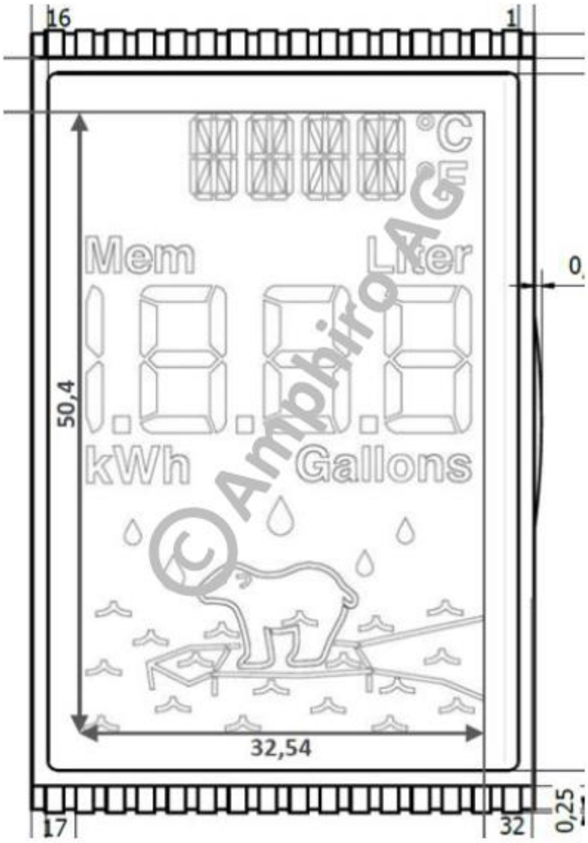
Mechanical Drawing



7.5. Datasheet Thermistor



7.6. Display



7.7. CE Declaration

Declaration of conformity

We:

Amphiro AG

Badenerstrasse 60

CH-8004 Zurich

Switzerland

Declare:

Under our sole responsibility that the following labelled devices

amphiro b1

to which this declaration relates, are, when used according to specification, in conformity with the technical requirements of the standards and the provisions of the essential requirements of the directives detailed below.

Standards used:

DIN EN 60950-1:2014

DIN EN 55014-1:2012

DIN EN 55014-2:2009

ETSI EN 301 489-1 V1.9.2

ETSI EN 301 489-17 V2.2.1

ETSI EN 300 328 V1.8.1

Place of issue: Zürich, Switzerland | Date of issue: 04.04.16

Chief Executive Officer:

Dr. Thomas Stiefmeier

Signature:

7.8. Manual Amphiro b1 connect

amphiro

amphiro b1 smart shower meter

Hot water equals energy

You decide how much energy you use – for a variety of things. With amphiro b1 you keep track of your hot water consumption. That way, you can pursue energy efficiency goals or simply get a sense for your personal resource utilization in the shower. The information provided enables you to consciously use thermal energy and motivates sustainable use of precious resources.

Act consciously and conserve energy

With amphiro b1, households reduce their annual thermal energy consumption by 440 kWh and their drinking water consumption by 8'500 litres on average. That way you make an important contribution to reaching the efficiency goals of our society and at the same time you reduce your water and energy bills.

spinoff ETH

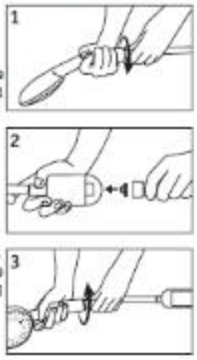
Installation in three easy steps

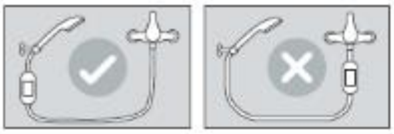
amphiro b1 is designed for your handheld showerhead.

1. **Unscrew the showerhead** from the hose.

2. Remove the red adhesive tape at the bottom end of amphiro b1 and ensure that the sleve stays in place: the convex (curved) side must point towards the interior of the device. **Screw the shower hose onto this connector with the sleve.**

3. **Screw the showerhead into the short hose on amphiro b1.** Be sure to remove the safety cap first and ensure that the sealing ring stays in place inside the hose.





Your smart meter for the shower

amphiro b1 displays the water and energy consumption for every individual shower taken. After a couple of minutes of interruption, a new measurement will start and the display will be reset to zero.

Temperature display
During the shower: Information about the water temperature in Celsius.

Water and energy consumption
- During the shower: Water consumption in litres.
- After the shower: Alternating display of a) energy consumption in Watt-hours (Wh) / kilowatt-hours (kWh). b) water consumption in litres.

Climate animation
Iceberg melts with increasing energy consumption.

Get connected with the Amphiro app

amphiro b1 transmits your consumption data via Bluetooth 4.0® to your mobile iOS or Android device. As soon as you are connected, you can track your consumption data and benefit from various support features.

How to install the free app

1. Download the free Amphiro app for your iOS or Android smart device at Apple's App Store or at Google's Play Store (search for amphiro b1).

2. Connect your smartphone with a Bluetooth 4.0® connection.

3. Once connected, start the Amphiro app and get access to your personal consumption data and benefit from our support features.

! Please note that your smarphone must support Bluetooth 4.0® to connect to amphiro b1.

! Your personal consumption account contains information about your water consumption, the number of showers taken and the water temperature. All information will be treated confidentially and will be evaluated anonymously.

No batteries – powered by the water

amphiro b1 does not use batteries. The device is powered only by the water flow. Once the water flow stops, the device will turn off automatically after a while.

Instructions for use

Please read these instructions carefully.

- Do not submerge the device in water. Do not let it float in the bathtub.
- Do not apply any decalcifiers or abrasive cleaning agents (scouring powder/milk), as they may damage the display.
- This device is not a toy and not suitable for small children. It contains small parts which may be swallowed.
- Do not open the device. Doing so will irreparably damage it, as the compartment sealing will be compromised.
- The device contains a strong permanent magnet as found for example in earphones. Individuals with a pacemaker should maintain an appropriate safety distance.
- The displayed energy consumption does not account for boiler/ furnace efficiency or transportation losses. The values are therefore not suitable for billing purposes.

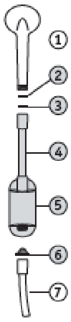
Answers to frequently asked questions can be found at www.amphiro.com/faq or contact info@amphiro.com

Symbols to be found on the device:
WEEE-Symbol: This product must not be disposed with other waste
CE-Certification-Symbol: This product complies with the relevant EU legislation applicable to this product
Device Serial-Number

This package contains

The emphasized elements are part of this package:

1. Showerhead (part of your shower)
2. **Protective cap** (to be removed before installation)
3. **Sealing ring** (underneath the cap at one end of the short hose)
4. **Short hose**
5. **amphiro b1 smart shower meter**
6. **Sleve with sealing gasket**
7. Shower hose (part of your shower)



Technical information

All terminals	½" standard screw
Application	Water flow range: 5 to 20 litres per minute Temperature: 5 °C to 65 °C Max. pressure: 10 bar
Protection against moisture	Waterproof in accordance with IP65. Do not submerge device in water.
Connection	Bluetooth 4.0® required.
Accuracy	± 10% at 12 litres per minute. Greater deviations may occur at different flow rates.

Manufacturer: Amphiro AG, Limmatstrasse 183, CH-8005 Zurich

7.9. Datasheet Gear-type Pump

Verdergear
Zahnradpumpe H7F

VERDERGEAR

Beschreibung
Verdergear Zahnradpumpen sind hervorragend für anspruchsvolle Anwendungen im Bereich der Fluidförderung für Gefahrgüter oder teure Chemikalien geeignet. Sie arbeiten pulsationsfrei und ohne Leckagen. Die Serie Verdergear Process besteht aus 10 Modellen für die verschiedensten Leistungsbereiche. Alle Verdergear Process Zahnradpumpen können mit verschiedenen Motorvarianten (z.B. mit integriertem Frequenzumrichter) geliefert werden.

Technische Daten	
Max. Fördermenge	40,5 l/min
Anschlüsse	¾" BSPT oder Flansch
Max. Differenzdruck	15,5 bar
Max. Systemdruck	15,5 bar
Temperaturbereich	-40 bis +260 °C
Max. Viskosität	100.000 mPas
Gewicht (Wellenabdichtung)	13 kg
Gewicht (Magnetgekupplung)	16 kg

Ihr Nutzen
- Pulsationsfreie Förderung
- Sehr zuverlässig
- Hohe Dosiergenauigkeit
- Korrosionsbeständige Werkstoffe
- Sehr servicefreundlich

Pumpenschlüssel
Nr. 1 Nr. 2 Nr. 3 Nr. 4 Nr. 5 Nr. 6 Nr. 7 Nr. 8 Nr. 9 Nr. 10 Nr. 11 Nr. 12 Nr. 13 Nr. 14 Nr. 15 Nr. 16 Nr. 17

Nr. 1 Baugröße
H7

Nr. 2 Fördervolumen
F = Volle Fördermenge
N/R = Reduzierte Fördermenge

Nr. 3 Werkstoff Gehäuse
E = 316 SS DIN PN 16 geflanscht
F = Alloy-C DIN PN 16 geflanscht
H = Alloy-C NPT
S = 316 SS NPT
X = 316 SS BSPT
Y = Alloy-C BSPT

Nr. 4 Werkstoff treibendes Zahnrad
1 = Alloy-C
3 = Teflon
6 = 316 SS
K = Kynar
P = PEEK

Nr. 5 Werkstoff getriebenes Zahnrad
1 = Alloy-C
2 = Karbon
3 = Teflon
6 = 316 SS
8 = Ryton
K = Kynar
P = PEEK

Nr. 6 Werkstoff Schleißplatten
3 = Teflon
4 = Keramik
E = Karbon 60
P = PEEK

Nr. 7 Werkstoff Lager
3 = Teflon
B = SiC
E = Karbon 60
P = PEEK

Nr. 8 Dichtung
2 = Magnet 14 mm (IEC 71-B5)
3 = Magnet 19 mm (IEC 80-B5)
4 = Magnet 24 mm (IEC 90-B5)
8 = Magnet 28 mm (IEC 100/112-B5)
U = Einfache GLRD Kohle-Keramik
S = Einfache GLRD Teflon-Keramik
F = Doppelte GLRD Kohle-Keramik
H = Doppelte GLRD Teflon-Keramik
L = Packung Teflon
R = Packung Grafoil

Nr. 9 Lagerspülung
0 = Ohne
1 = Externe Lagerspülung
2 = Interne Lagerspülung

Nr. 10 Welle
0 = Standard (Edelstahl)
1 = Keramik beschichtet
2 = WC beschichtet

Nr. 11 Werkstoff O-Ring
0 = Teflon
E = EPDM
6 = 316 SS/PFA encap.
V = Viton
B = Buna-N
K = Kalrez

Nr. 12 Sicherungsring
0 = Gehäusematerial

Nr. 13 Werkstoff Lagerstift
0 = Teflon
1 = Alloy-C
6 = 316 SS

Nr. 14 Kupplung
2 = IEC 71-B5
3 = IEC 80-B5
4 = IEC 90-B5
8 = IEC 100/112-B5
9 = Freies Wellenende
U = 75 in-lbs
B = 120 in-lbs
V = 200 in-lbs

Nr. 15 Optionen
8 = Temperatur Trim
9 = Viskosität Trim
D = Doppelter Spalttopf
S = Standardspalttopf

Nr. 16 Leistung in kW
z.B. 0,18 = 0,18 kW

Nr. 17 Drehzahl
z.B. 1000 = 1000 U/min

Nr. 17 Ausführung
TF = 400 V / 3 Phasen / 3 Kaltleiterfühler

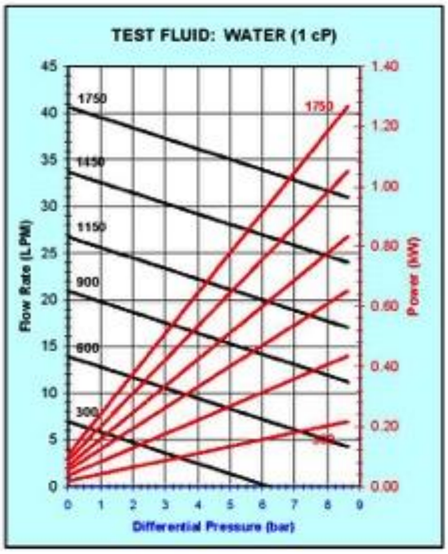
BEISPIEL PUMPENSCHLÜSSEL
H7FE113330000038 1,10/1500TF

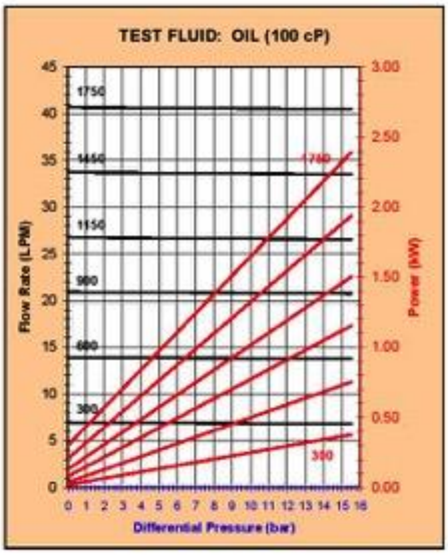
Achtung: Nicht alle Kombinationen verfügbar

Besuchen Sie auch unseren Webshop unter shop.verder.de

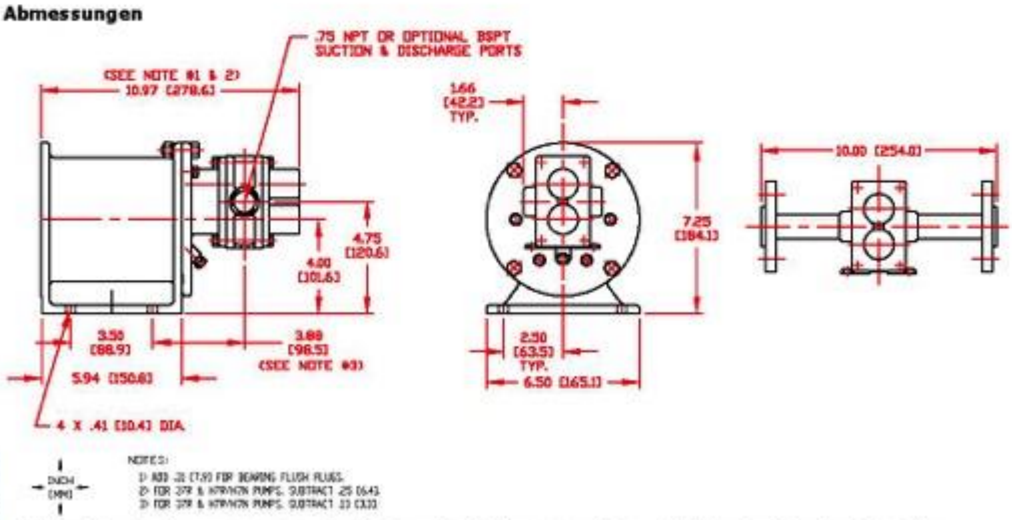
Verdergear
Zahnradpumpe H7F

Kennlinie





Abmessungen



Bitte beachten Sie: Abmessungen entsprechen Motorbaugröße 132. Abmessungen können sich bei anderen Motorbaugrößen ändern.

VERDER DEUTSCHLAND GmbH & Co. KG
TEL +49 (0)2104 23 33-200
MAIL info@verder.de
WEB www.verder.de

VERDER GmbH AUSTRIA
TEL +43 (0)1 865 10 74-0
MAIL office@verder.at
WEB www.verder.at

VERTRIEB SCHWEIZ
TEL +41 (0) 61 331 33 13
MAIL info@verder.ch
WEB www.verder.ch

VERDER
passion for pumps

7.10. Datasheet Pressure Sensor

Pressure Sensors

24PC Series

Gage and Differential/Unamplified-Noncompensated

Basic Sensors

FEATURES

- Miniature package
- Variety of gage pressure port configurations - easily and quickly modified for your special needs
- Operable after exposure to frozen conditions
- Ideal for wet/wet differential applications
- Choice of termination for gage sensors
- 2 mA constant current excitation significantly reduces sensitivity shift over temperature*
- Can be used to measure vacuum or positive pressure

Unamplified

24PC SERIES PERFORMANCE CHARACTERISTICS at 10.0 ±0.01 VDC Excitation, 25°C

	Min.	Typ.	Max.	Units
Excitation	—	10	12	VDC
Null Offset	−30	0	+30	mV
Null Shift, 25° to 0°, 25° to 50°C	—	±2.0	—	mV
Linearity, P2 > P1, BFSL	—	±0.25	±1.0	%Span
Span Shift, 25° to 0°, 25° to 50°C	—	±5.0*	—	%Span
Repeatability & Hysteresis	—	±0.15	—	%Span
Response Time	—	—	1.0	msec
Input Resistance	4.0 K	5.0 K	6.0 K	ohms
Output Resistance	4.0 K	5.0 K	6.0 K	ohms
Stability over One Year	—	±0.5	—	%Span
Weight	—	2	—	grams

ENVIRONMENTAL SPECIFICATIONS

Operating Temperature	−40° to +85°C (−40° to +185°F)
Storage Temperature	−55° to +100°C (−67° to +212°F)
Shock	Qualification tested to 150 g
Vibration	Qualification tested to 0 to 2 kHz, 20 g sine
Media (P1 & P2)	Limited only to those media which will not attack polyetherimide, silicon, fluorosilicone, silicone, EPDM and neoprene seals.

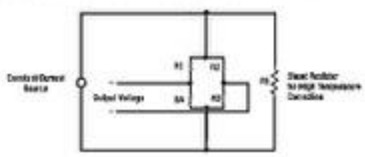
24PC SERIES ORDER GUIDE

Catalog Listing	Pressure Range psi	Span, mV Min.	Span, mV Typ.	Span, mV Max.	Sensitivity mV/psi Typ.	Overpressure psi Max.
24PCE Type	0.5	24	35	46	70	20
24PCA Type	1.0	30	45	60	45	20
24PCB Type	5.0	85	115	145	23	20
24PCC Type	15	165	225	285	15	45
24PCD Type	30	240	330	420	11	60
24PCF Type	100	156	225	294	2.25	200
24PCG Type	250	145	212	280	0.85	500

* Non-compensated pressure sensors, excited by constant current instead of voltage, exhibit temperature compensation of Span. Application Note #1 briefly discusses current excitation.

Constant current excitation has an additional benefit of temperature measurement. When driven by a constant current source, a silicon pressure sensor's terminal voltage will rise with increased temperature. The rise in voltage not only compensates the Span, but is also an indication of die temperature.

Constant Current Excitation Schematic



Honeywell • Sensing and Control • 1-800-537-6945 USA • +1-815-235-6847 International • 1-800-737-3360 Canada 11

Pressure Sensors

Gage and Differential/Unamplified-Noncompensated

24PC Series

SENSOR SELECTION GUIDE

2 Product Family	4 Circuit Type	PC Pressure Transducer	A Pressure Range	F* Type of Seal	A Type of Port	2 Termination Style	G Pressure Measurement
2 20PC family	**4** Noncom-pensated		**A** 1 psi **B** 5 psi **C** 15 psi **D** 30 psi **E** 0.5 psi **F** 100 psi **G** 250 psi	**E** EPDM **F** Fluorosilicone **N** Neoprene **S** Silicone	**A** Straight **B** Barbed **C** Luer **D** Modular **H** M5 Thread **I** 90° Port **J** Needle **K** Reverse 98 Port **L** 1/4 - 28 UNF w/Cable Lock **M** 1/4 - 28 UNF w/o Cable Lock **S** Manifold	**1** 1 x 4 (.400") **2** 2 x 2 **6** 1 x 4 (.600")	**G** Gage **D** Differential

Example: 24PCAFA2G
Standard, non-compensated 1 psi sensor with fluorosilicone seal, straight port, 2 x 2 terminals, and Gage pressure measurement.
*Other media seal materials may be available.

See Accessory Guide, page 27.

Not all combinations are established. Contact 800 number before final design.

7.11. Datasheet Magnetic Valves

2/2-Wege Magnetventile

für **Trinkwasser-Anwendungen**

321K4.13 Baureihe NC normal geschlossen
322K4.13 Baureihe NO normal offen

Das Produkt:

Die 2/2-Wege Magnetventile der Parker 321K4 .13 Baureihe sind für den Einsatz mit Trinkwasser ausgelegt und entsprechend durch die SVGW Technischen Prüfstelle Wasser mit Zertifikat Nr 9303-3013 für entsprechende Anwendungen zugelassen.

Bei dieser Baureihe handelt es sich um vorgesteuerte 2/2-Wege Membranventile in den Baugrössen von G1/4" bis G 1", die sich durch eine besondere kompakte Bauweise und extrem einfache Wartung auszeichnen.

Alle Werkstoffe wurden entsprechend der Trinkwasser-Verordnung ausgewählt.

Dank des modularen Designs ist diese Generation nicht nur für den Einsatz im Innenbereich, sondern auch für Anwendungen im Freien und in explosionsgefährdeten Bereichen geeignet.

Kontakt Information:

Parker Hannifin S.p.A
Automation Group
Fluid Control Division Europe
Via E. Fermi, 5
IT - 20060 Gessate (MI)
Tel.: +39 02 95 125 1
Fax: +39 02 95 382 051

Anwendungen:

2/2-Wege Magnetventile zur Verwendung:

- Mit Trinkwasser
- Zur Getränke-Abfüllung
- In Kaffeemaschinen
- In Wasserspendern
- Und vielem mehr

Vorteile:

- Trinkwasser-Zulassung
- Kompaktes Design
- Höchste Zuverlässigkeit
- Einfache Wartung
- Vielfältige Einsatzmöglichkeiten

Parker

ENGINEERING **YOUR** SUCCESS.

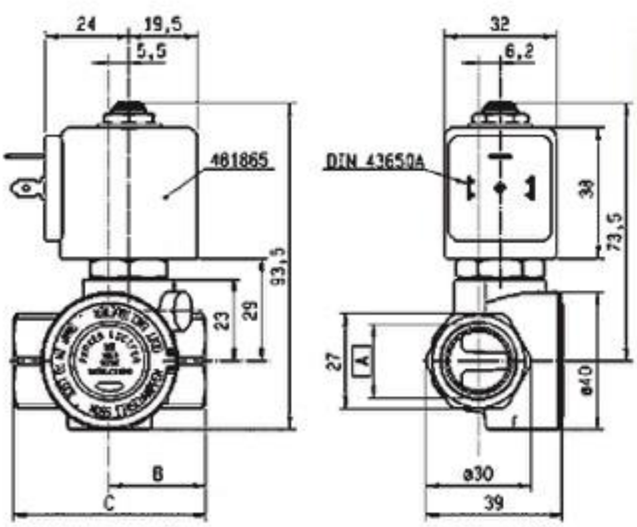
Technische Daten:

NC - Normal geschlossen

Ventil	G	Spulen gruppe	Nennw	KV l/min.	Druckbereichbar Min.	Max. AC	Max. DC	Temperaturbereich Min. °C	Max. °C	Sitz
321K4113 -2995.13	1/4	2.0	12	32	0.3	10	10	0	90	EPDM
321K4313 -2995.13	3/8	2.0	12	45	0.3	10	10	0	90	EPDM
321K4513 -2995.13	1/2	2.0	12	50	0.3	10	10	0	90	EPDM
321K4613 -2995.13	3/4	2.0	18	100	0.3	10	10	0	90	EPDM
321K4713 -2995.13	1	2.0	18	110	0.3	10	10	0	90	EPDM

NO - Normal offen

Ventil	G	Spulen gruppe	Nennw	KV l/min.	Druckbereichbar Min.	Max. AC	Max. DC	Temperaturbereich Min. °C	Max. °C	Sitz
322K4113 -2995.13	1/4	2.0	12	32	0.3	10	10	0	90	EPDM
322K4313 -2995.13	3/8	2.0	12	45	0.3	10	10	0	90	EPDM
322K4513 -2995.13	1/2	2.0	12	50	0.3	10	10	0	90	EPDM
322K4613 -2995.13	3/4	2.0	18	100	0.3	10	10	0	90	EPDM
322K4713 -2995.13	1	2.0	18	110	0.3	10	10	0	90	EPDM



	A	B	C
321/322K41	G 1/4"	25	50
321/322K43	G 3/8"	25	50
321/322K45	G 1/2"	27.5	55
321/322K46	G 3/4"	40	80
321/322K47	G 1"	42.5	85

Für diese Baureihe stehen Ihnen eine Vielzahl von verschiedenen Magnetspulen für die unterschiedlichsten Einsatzbereiche und in allen Standard-Spannungen zur Verfügung.

Die moderne und einfache (patentierte) Konstruktion der Ventildeckels ermöglicht allfällige Wartungsarbeiten in-line d.h in eingebautem Zustand des Ventiles.

Ersatzteil-Sätze sind auf Anfrage verfügbar.

Bestell-Beispiel:
321K4513-2995.13-4818653D
2/2-Wege, G 1/2", Normal geschlossen, 230V/50Hz.

FCDE 5312/DE - 02/2014

EMEA-Produktinformationszentrum
Gebührenfrei: 00 800 27 27 5374
(aus AT, BE, CH, CZ, DE, DK, EE, ES, FI, FR, IE, IL, IS, IT, LU, MT, NL, NO, PL, PT, RU, SE, SK, UK, ZA)
US-Produktinformationszentrum
Gebührenfrei: 1-800-27 27 537
www.parker.com

Parker

7.12. Datasheet Flow Rate Sensor

Der Flowmeter FHKU-LCD ist ein universell einsetzbares Durchflussmessgeräte, je nach Düsengrösse kann individuell der Messbereich bestimmt werden. Gewährleistet genaueste Flüssigkeitsmengen-Messungen. Hervorragend geeignet zur Überwachung von Ionenaustauscher Filterpatronen und zur Aufbereitung von Wasser.

Spezialitäten: Verwaltung von Zeit und Datum, Zähler aufwärts und Zähler abwärts, History mit Datum, Momentanwert-Anzeige, Automatische Impulseichung, Liter und /oder Datum-Alarm, Schutz-Code um unautorisierte Manipulationen zu verhindern. Stromversorgung über Lithium Batterie. Bei einem Batteriewechsel werden alle Einstellungen und Werte gespeichert.

Zulassungen / Normen

EMV-Anforderung:

EN 61326: 1997 +A1:1998 + A2: 2001

(IEC 61326: 2002)

CE NSF COMPONENT

Material Flowmeter:

Gehäuse:	PBT 35%GF (Arnite)
Lagerstift:	Inox 1.4305 (18/8)
O-Ring:	MVQ (Silikon)
Turbine:	PVDF
Magnete:	Keramik Sr Fe O (Medium berührend)
Schraube:	PT-Schraube (Phillips Kreuzschlitz)
Kabel:	1.5 Meter, PVC 2 x 0.25mm²

Technische Daten Flowmeter:

Durchflussmenge:	3 - 30 l/min
Messgenauigkeit:	+/- 2.0%
Repetition:	<+/- 0.25%
Temperaturbereich:	0°C bis +60°C 32°F bis 140°F
Druckbereich:	10 bar bei 20°C 145 psi /68°F
Einbaulage:	Horizontal empfohlen
Düsengrössen:	Ø 10.0 mm

Technische Daten Anzeige extern:

Spritzwasserdicht:	IP X4
Limit-Messung:	1 - 99999 Liter
Impulse/Liter:	1 - 65000
Statischer Speicher:	5 letzten Nullstellungen
Anzeige:	5 Stellen
Zähler:	Aufwärts 0 bis 99999 Liter mit oder ohne Limit Abwärts von 99999 bis -9999 Liter
Momentanwert:	l/min
Batterie:	Lithium CR 2032
Anzeigegehäuse:	Polycarbonat

Abmessungen in mm: