Attention : ce devoir est composé de 2 parties distinctes. Une partie « Cours » et une partie « TP ».

Nous vous conseillons de passer 1H30 sur la partie « Cours » et 30mn sur la partie TP

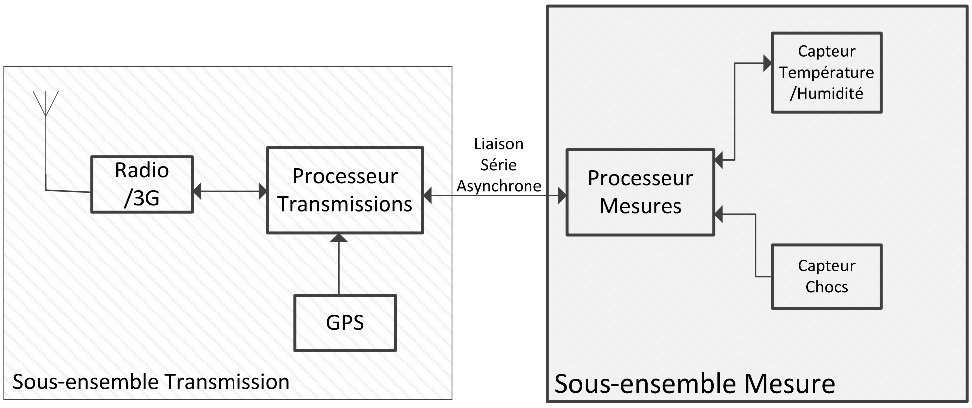
La partie « Cours » traite des aspects généraux du module BSE, tandis que la partie « TP » s'appuie sur des compétences pratiques acquises en TP.

La partie « Cours » entrera dans l'évaluation COURS et la partie « TP » entrera dans l'évaluation TP

Cahier des charges

« Module de surveillance de container »

On souhaite pouvoir connaitre en permanence l'état d'un container. Outre sa géolocalisation, on veut mesurer sa température et son hygrométrie interne et déterminer s'il est soumis à de chocs trop importants.
Le dispositif complet sera en mesure de transmettre en temps réel des informations sur la position géographique du container ainsi que des informations sur l'état du container. Plusieurs modes de fonctionnement pourront être envisagés, de la transmission en continue des mesures jusqu'à une transmission limitée aux alarmes de dépassement de seuils en passant par un relevé régulier de valeurs moyennes.
C'est le sous-ensemble ***Transmission*** qui sera chargé de gérer ces différents scénarios, tandis que le sous–ensemble ***Mesure*** sera chargé de gérer les différents capteurs.
Nous vous proposons de participer à la conception du sous-ensemble ***Mesure*** en vous intéressant plus particulièrement à la conception bas niveau des interfaces logicielles des divers capteurs et de la liaison entre le processeur Mesures et le processeur Transmissions.



Caractéristiques globales du sous-ensemble Mesure :

- Processeur Mesures : microcontrôleur 8051F020 – Un quartz de 18,432 MHz est connecté au microcontrôleur.
- Capteur Température et Hygrométrie : capteur RHT03 de Maxdêtect
- Capteur de chocs : accéléromètre 3 voies ADXL377 d'Analog-Devices
- Liaison entre le processeur Transmissions et le processeur Mesures : liaison série asynchrone.

Caractéristiques détaillées des dispositifs.

Accéléromètre 3 voies ADXL377 – Voir documentation en Annexe
- Utilisation des 3 axes du capteur.
- Bande passante de 0 à 1000Hz. En conséquence la fréquence d'échantillonnage est fixée à 5KHz
- Gamme de mesure +/- 100g – Résolution de la mesure : supérieure à 0,5g.
- Alimentation 3,3V

Capteur de température et d'humidité : RHT03 – Voir documentation en Annexe
- La fréquence de mesure sera inférieure ou égale à 1 Hz
- Alimentation 3,3V

Liaison série asynchrone le processeur Transmission et le processeur Mesures :
- Vitesse de transmission 57600 Bauds
- 8bits de donnée – Pas de parité – 1 stop bit

Small, Low Power, 3-Axis ±200 *g* Accelerometer

Data Sheet **ADXL377**

FEATURES

3-axis sensing
Small, low profile package
3 mm × 3 mm × 1.45 mm LFCSP
Low power: 300 µA (typical)
Single-supply operation: 1.8 V to 3.6 V
10,000 *g* shock survival
Excellent temperature stability
Bandwidth adjustment with a single capacitor per axis
RoHS/WEEE and lead-free compliant

APPLICATIONS

Concussion and head trauma detection
High force event detection

GENERAL DESCRIPTION

The ADXL377 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The ADXL377 measures acceleration resulting from motion, shock, or vibration with a typical full-scale range of ±200 *g*.

The user selects the bandwidth of the accelerometer using the C_X, C_Y, and C_Z capacitors at the X_{OUT}, Y_{OUT}, and Z_{OUT} pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1300 Hz for the x-axis and y-axis and a range of 0.5 Hz to 1000 Hz for the z-axis.

The ADXL377 is available in a small, low profile, 3 mm × 3 mm × 1.45 mm, 16-lead lead frame chip scale package (LFCSP_LQ).

FUNCTIONAL BLOCK DIAGRAM

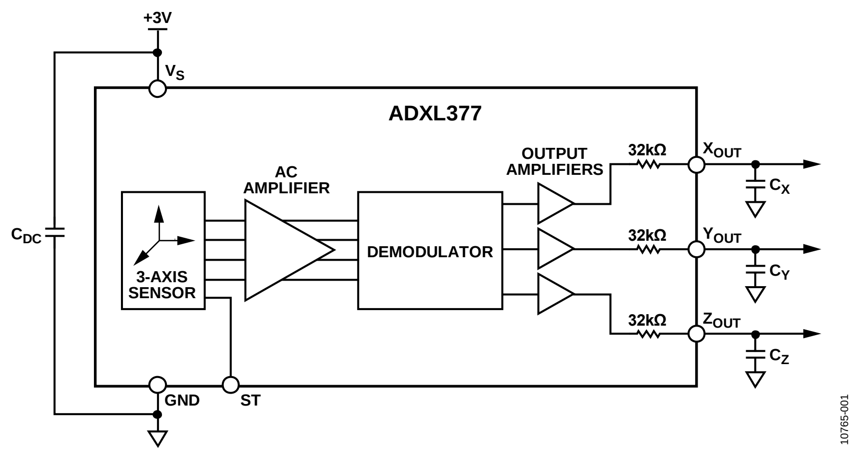


Figure 1.

Rev. 0 **Document Feedback**

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Technical Support **www.analog.com**

SPECIFICATIONS

T_A = 25°C, V_S = 3 V, C_X = C_Y = C_Z = 0.1 µF, acceleration = 0 *g*, unless otherwise noted. All minimum and maximum specifications are guaranteed. Typical specifications are not guaranteed.

Table 1.

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
SENSOR INPUT	Each axis				
Measurement Range			±200		*g*
Nonlinearity	% of full scale up to 180 *g*		±0.5		%
Cross-Axis Sensitivity[1]			±1.4		%
SENSITIVITY, RATIOMETRIC[2]	Each axis				
Sensitivity at X_{OUT}, Y_{OUT}, and Z_{OUT}	V_S = 3 V	5.8	6.5	7.2	mV/*g*
Sensitivity Change Due to Temperature[3]	V_S = 3 V		±0.02		%/°C
ZERO *g* BIAS LEVEL, RATIOMETRIC					
Zero *g* Voltage	V_S = 3 V, T_A = 25°C	1.4	1.5	1.6	V
Zero *g* Offset vs. Temperature					
X-Axis and Y-Axis			±12		m*g*/°C
Z-Axis			±30		m*g*/°C
NOISE PERFORMANCE					
Noise Density					
X_{OUT} and Y_{OUT}			2.7		m*g*/√Hz
Z_{OUT}			4.3		m*g*/√Hz
FREQUENCY RESPONSE[4]					
Bandwidth[5]	No external filter				
X_{OUT} and Y_{OUT}			1300		Hz
Z_{OUT}			1000		Hz
R_{FILT} Tolerance			32 ± 15%		kΩ
Sensor Resonant Frequency			16.5		kHz
SELF-TEST[6]					
Logic Input Low			0.6		V
Logic Input High			2.4		V
ST Actuation Current			60		µA
Output Change	Self-test, 0 to 1				
At X_{OUT}			−6.5		mV
At Y_{OUT}			6.5		mV
At Z_{OUT}			11.5		mV
OUTPUT AMPLIFIER	No load				
Output Swing Low			0.1		V
Output Swing High			2.8		V
POWER SUPPLY					
Operating Voltage Range[7]		1.8	3.0	3.6	V
Supply Current	V_S = 3 V		300		µA
Turn-On Time[8]	No external filter		1		ms
OPERATING TEMPERATURE RANGE		−40		+85	°C

[1] Defined as coupling between any two axes.
[2] Sensitivity is essentially ratiometric to V_S.
[3] Defined as the output change from ambient temperature to maximum temperature or from ambient temperature to minimum temperature.
[4] Actual frequency response controlled by user-supplied external filter capacitors (C_X, C_Y, and C_Z).
[5] Bandwidth with external capacitors = $1/(2\pi \times 32\ k\Omega \times C_X)$.
[6] Self-test response changes cubically with V_S.
[7] Tested at 3.0 V and guaranteed by design only (not tested) to work over the full voltage range from 1.8 V to 3.6 V.
[8] Turn-on time is dependent on C_X, C_Y, and C_Z and is approximately 160 × (C_X or C_Y or C_Z) + 1, where C_X, C_Y, and C_Z are in µF and the resulting turn-on time is in ms.

Digital relative humidity & temperature sensor RHT03

1. Feature & Application:

*High precision
*Capacitive type
*Full range temperature compensated
*Relative humidity and temperature measurement
*Calibrated digital signal
*Outstanding long-term stability
*Extra components not needed
*Long transmission distance, up to 100 meters
*Low power consumption
*4 pins packaged and fully interchangeable

2. Description:

RHT03 output calibrated digital signal. It applys exclusive digital-signal-collecting-technique and humidity sensing technology, assuring its reliability and stability. Its sensing elements is connected with 8-bit single-chip computer.
Every sensor of this model is temperature compensated and calibrated in accurate calibration chamber and the calibration-coefficient is saved in type of programme in OTP memory, when the sensor is detecting, it will cite coefficient from memory.
Small size & low consumption & long transmission distance(100m) enable RHT03 to be suited in all kinds of harsh application occasions. Single-row packaged with four pins, making the connection very convenient.

3. Technical Specification:

Model	RHT03
Power supply	3.3-5.5V DC
Output signal	digital signal via MaxDetect 1-wire bus
Sensing element	Polymer humidity capacitor
Operating range	humidity 0-100%RH; temperature -40~80Celsius
Accuracy	**humidity +-2%RH**(Max +-5%RH); temperature +-0.5Celsius
Resolution or sensitivity	humidity 0.1%RH; temperature 0.1Celsius
Repeatability	humidity +-1%RH; temperature +-0.2Celsius
Humidity hysteresis	+-0.3%RH
Long-term Stability	+-0.5%RH/year
Interchangeability	fully interchangeable

4. Dimensions: (unit----mm)

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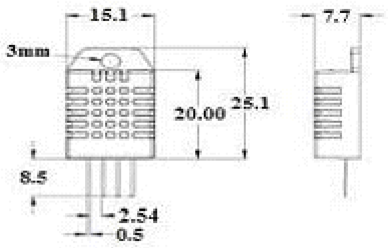
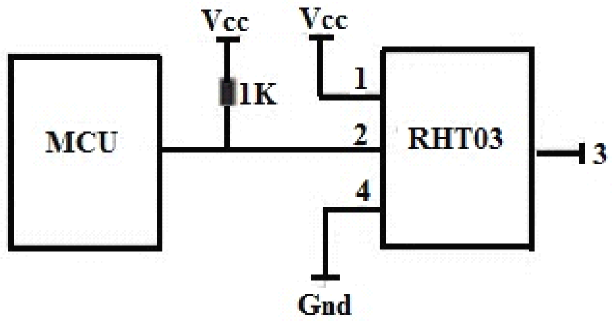


Pin sequence number: 1 2 3 4 (from left to right direction).

Pin	Function
1	VDD—power supply
2	DATA–signal
3	GND
4	GND

5. Electrical connection diagram:



6. Operating specifications:

(1) Power and Pins

Power's voltage should be 3.3-5.5V DC. When power is supplied to sensor, don't send any instruction to the sensor within one second to pass unstable status. One capacitor valued 100nF can be added between VDD and GND for wave filtering.

(2) Communication and signal

MaxDetect 1-wire bus is used for communication between MCU and RHT03. (MaxDetect 1-wire bus is specially designed by MaxDetect Technology Co., Ltd. , it's different from Maxim/Dallas 1-wire bus, so it's incompatible with Dallas 1-wire bus.)

Illustration of MaxDetect 1-wire bus:

DATA=16 bits RH data+16 bits Temperature data+8 bits check-sum

Example: MCU has received 40 bits data from RHT03 as

0000 0010 1000 1100 0000 0001 0101 1111 1110 1110

16 bits RH data 16 bits T data check sum

Here we convert 16 bits RH data from binary system to decimal system,

0000 0010 1000 1100 → 652

Binary system Decimal system

RH=652/10=65.2%RH

Here we convert 16 bits T data from binary system to decimal system,

0000 0001 0101 1111 → 351

Binary system Decimal system

T=351/10=35.1℃

When highest bit of temperature is 1, it means the temperature is below 0 degree Celsius.

Example: 1000 0000 0110 0101, T= minus 10.1℃

16 bits T data

Sum=0000 0010+1000 1100+0000 0001+0101 1111=1110 1110

Check-sum=the last 8 bits of Sum=1110 1110

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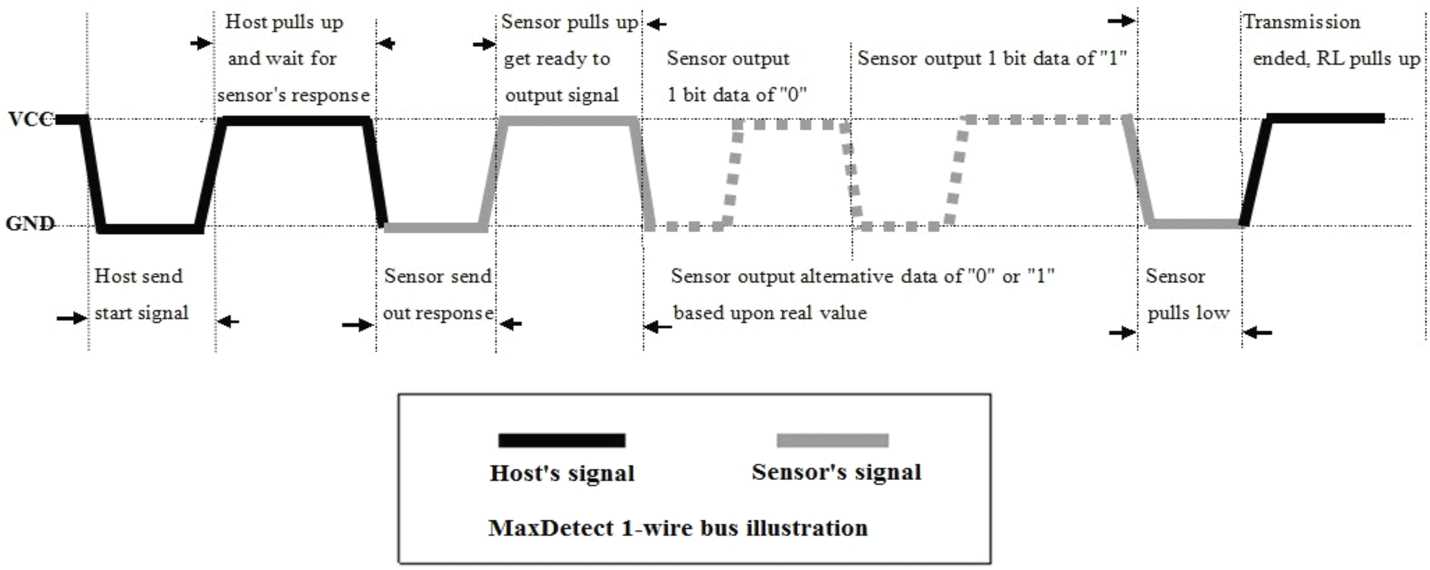
When MCU send start signal, RHT03 change from standby-status to running-status. When MCU finishs sending the start signal, RHT03 will send response signal of 40-bit data that reflect the relative humidity and temperature to MCU. Without start signal from MCU, RHT03 will not give response signal to MCU. One start signal for one response data from RHT03 that reflect the relative humidity and temperature. RHT03 will change to standby status when data collecting finished if it don't receive start signal from MCU again.

See below figure for overall communication process, **the interval of whole process must beyond 2 seconds.**



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1) Step 1: MCU send out start signal to RHT03 and RHT03 send response signal to MCU

Data-bus's free status is high voltage level. When communication between MCU and RHT03 begins, MCU will pull low data-bus and this process must beyond at least 1~10ms to ensure RHT03 could detect MCU's signal, then MCU will pulls up and wait 20-40us for RHT03's response.

When RHT03 detect the start signal, RHT03 will pull low the bus 80us as response signal, then RHT03 pulls up 80us for preparation to send data. See below figure:

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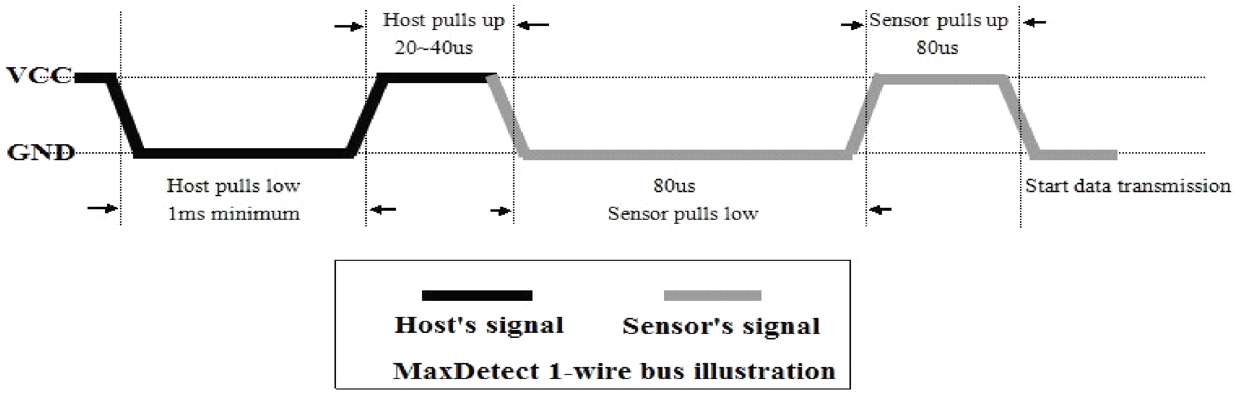

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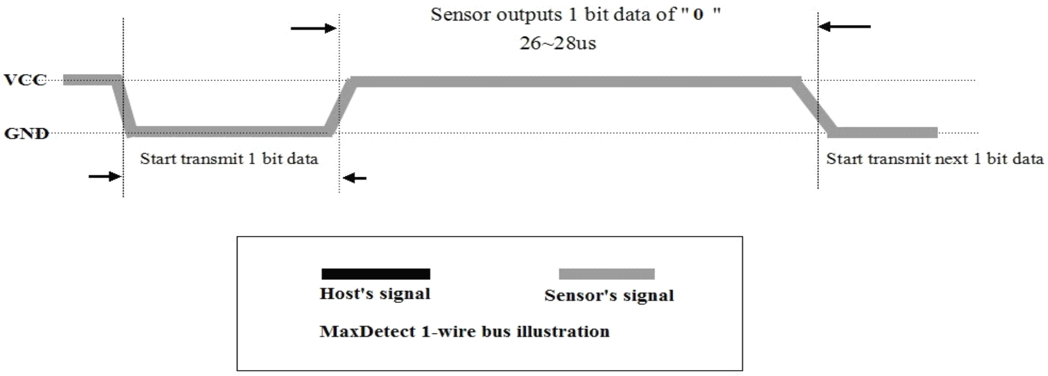
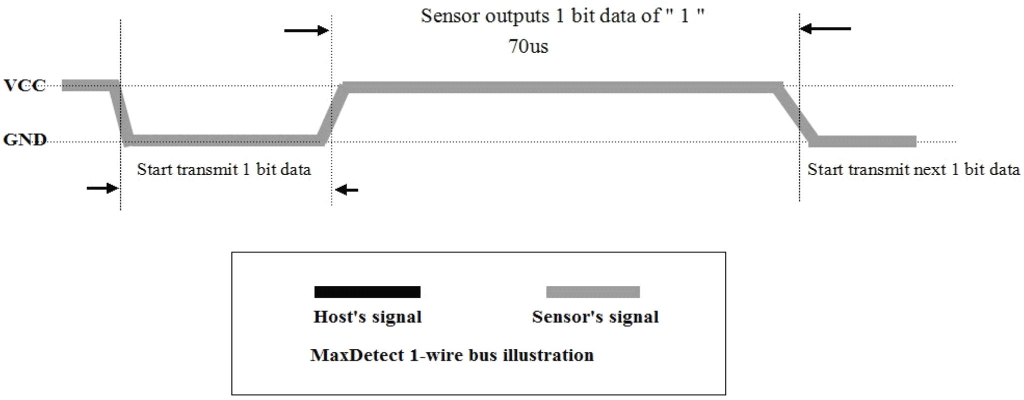
2). Step 2: RHT03 send data to MCU

When RHT03 is sending data to MCU, every bit's transmission begin with low-voltage-level that last 50us, the following high-voltage-level signal's length decide the bit is "1" or "0". See below figures:





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