Package Monitor

Group 7

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Background

- Rough handling of parcels
- Stolen and lost properties
- Broken parcels

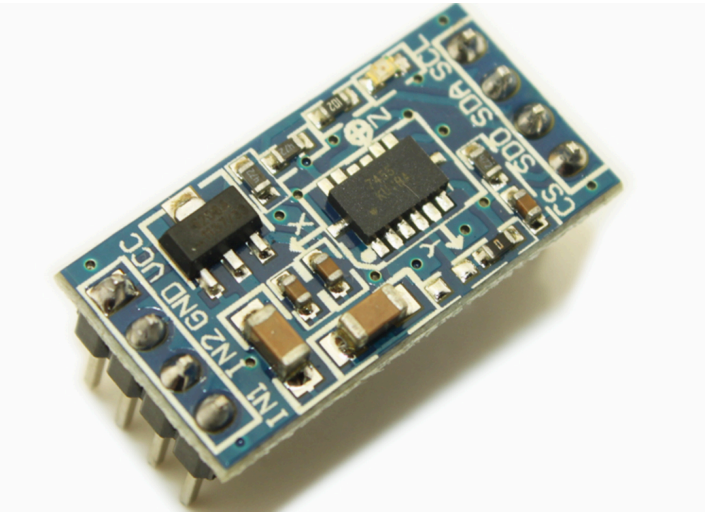
Solution

Package monitor

- Record acceleration in delivering process
- Record if the package has been opened in delivering process
- Show what happened to this package when Recipient got the package

Component

- MMA7455L



XYZ-axis accelerometer

±2g/±4g/±8g

Principle of operation

The center beam moves with acceleration, each capacitor value will change

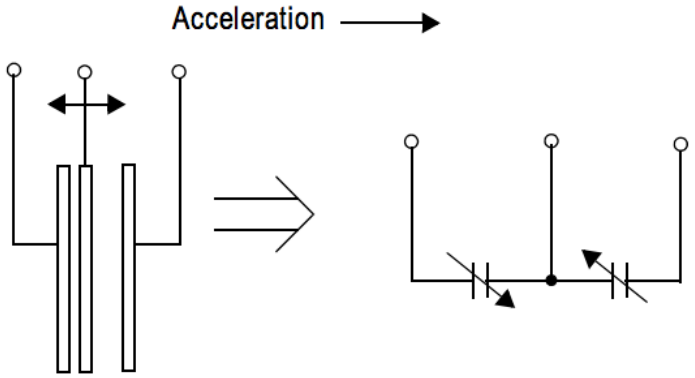


Figure 3. Simplified Transducer Physical Model

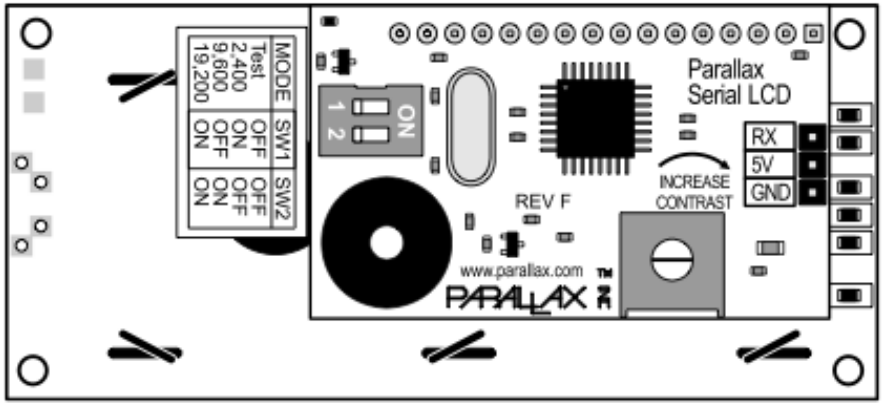
- Parallax Serial LCDs (Liquid crystal displays):

2 rows × 16 characters

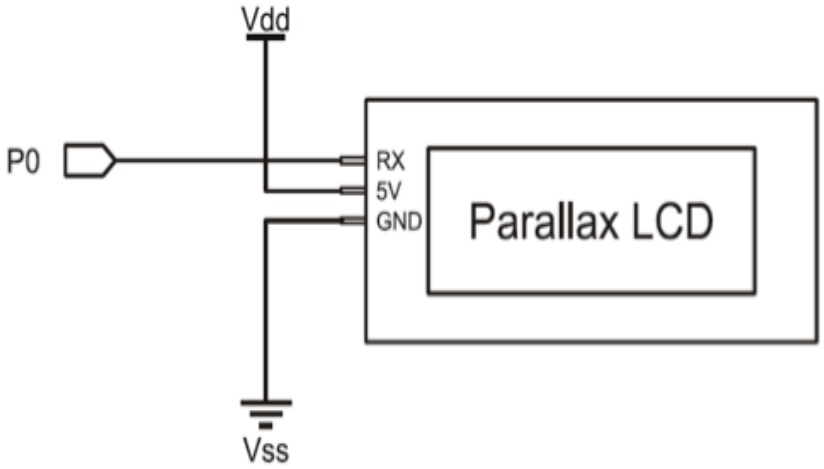
Power requirement: +5V DC, 20mA-80mA

- Parallax Serial LCDs (Liquid crystal displays):

MODE	SW1	SW2
Test	OFF	OFF
2,400	ON	OFF
9,600	OFF	ON
19,200	ON	ON



Switches are for self-testing and adjust baud rate

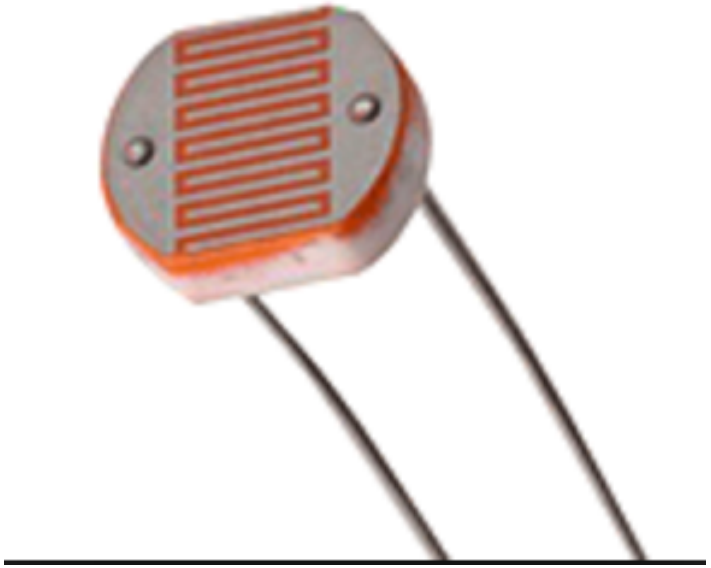


- Photoresistor

use as light sensor

Dark R↑

light R↓



Cost accounting

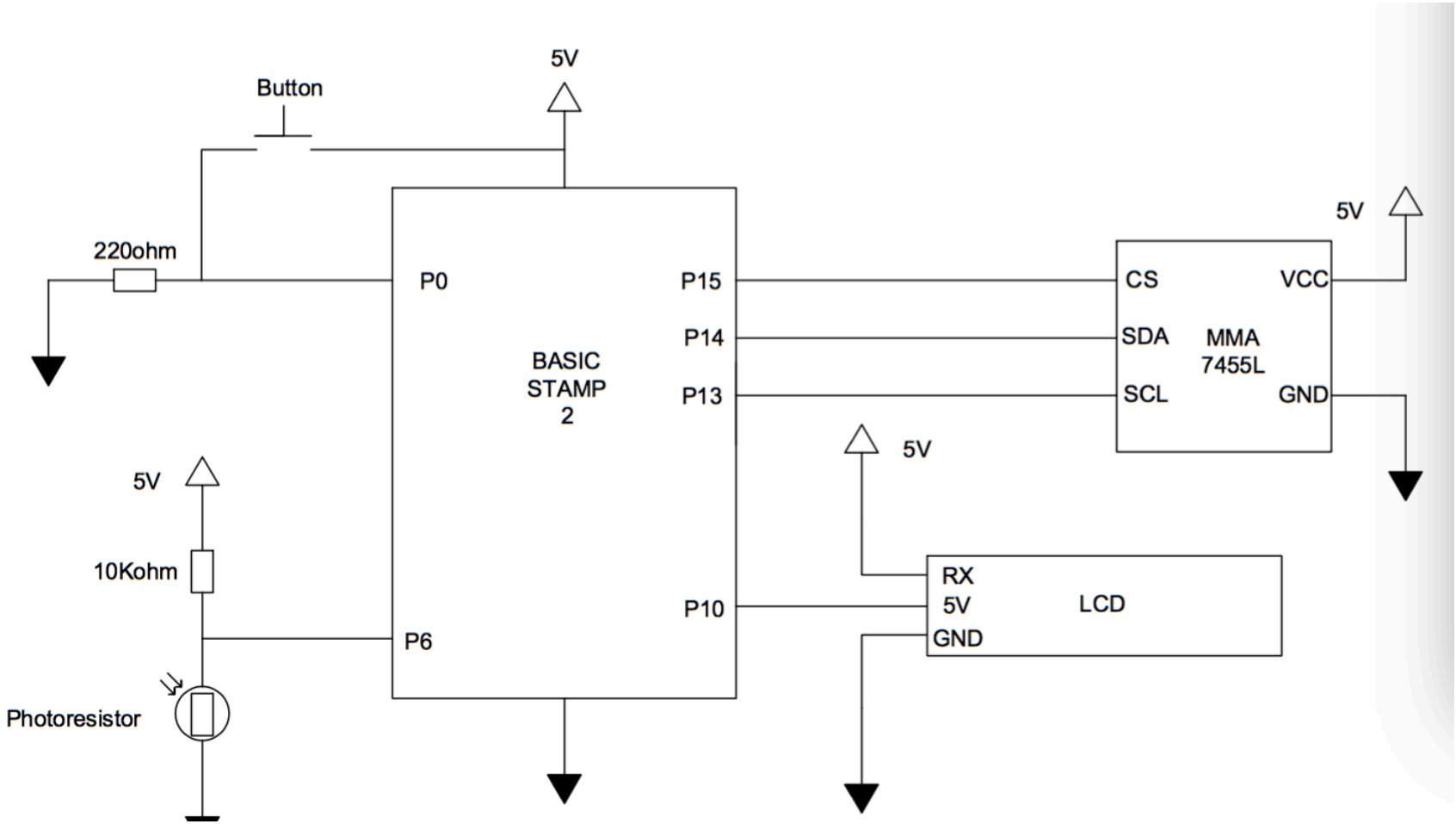
- bill of material:

Basic stamp 2 board	$ 22.90
MMA7455L - XYZ-axis accelerometer	$9.99
Parallax Serial LCDs (Liquid crystal displays)	$29.99
photoresistor	$0.1
resistors (10kΩ and 220Ω)	$0.1
wires	$0.1
total:	$63.18

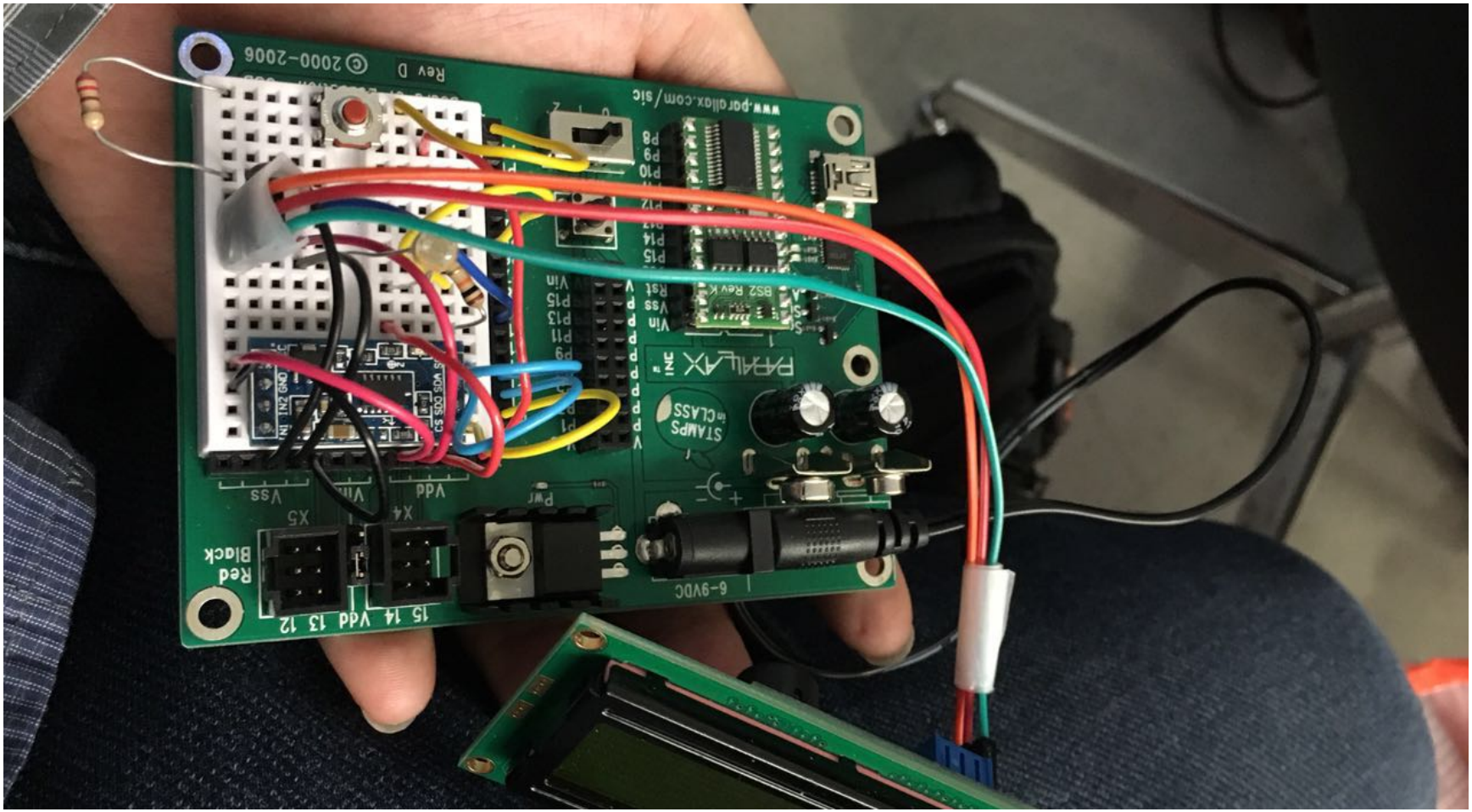
- Mass production cost

LCD displays	($2)
Mass production of microcontroller would be cheaper	($4)
Cheapest accelerometer	($3)
Others	($0.5)
Total:	$9.5

circuit


Button
5V
220ohm
P0
P15
P14
P13
BASIC
STAMP
2
CS
VCC
SDA
MMA
7455L
SCL
GND
5V
5V
5V
10Kohm
RX
5V
GND
LCD
P10
P6
Photoresistor

Circuit


Rev D
©2000-2006
www.parallax.com/sic
PARALLAX INC
STAMPS in CLASS
6-9VDC
Red
Black
Vdd
Vss
15 14 Vdd 13 12

Code

```
' {$STAMP BS2}
  ‘ {$PBASIC 2.5}
x VAR BYTE
CLKPin    PIN 13    ' Clock Pin
DATAPin   PIN 14    ' Data Pin
CSPin     PIN 15    ' Chip Select Pin
Control   PIN 0     ' Button Pin
Photo     PIN 6       ‘ Photoresistor Pin
XOUT8     CON $06   ' 8 bits output value X, All Address are 6 bits(1-6)
YOUT8     CON $07   ' 8 bits output value Y
ZOUT8     CON $08   ' 8 bits output value Z
MCTL      CON $16   ' Mode control
Vertrefresh CON 20  ' LCD shows the result after get 20 sets of data from sensor.
```

```
XAccel    VAR WORD  ' Variables to store incoming RAW data from the accelerometer
YAccel    VAR WORD
ZAccel    VAR WORD
Xmax      VAR WORD  ' Variables to store maximum data
Ymax      VAR WORD
Zmax      VAR WORD

Address   VAR WORD  ' Variables for reading and writing data to the acclerometer
SendData  VAR BYTE
ReceiveData VAR BYTE
Decimal   VAR WORD  ' Variable for changing data into decimal
Cycles    VAR BYTE  ' Variable to control the vertrefresh of LCD
Function  VAR BIT   ' Variable to switch the function of LCD
OpenTime  VAR BYTE  ' Variable to store the number of time the box opened.
```

```
Main:
  Address = MCTL: SendData = %01100001: GOSUB DataOut    'Set the Mode control register
                                                         'DATA ready status is NOT OUTPUT TO INT1 PIN
                                                         '3-wire SPI mode
                                                         'Self Test NOT enabled
                                                         '+/-8g sensitivity mode
                                                         'Measurement mode
  INPUT Control
  INPUT Photo
  Cycles=0                                               'Initialize Cycles
  Function=1                                             '1: real time; 0: max value of acceleration
  OpenTime=0                                             'Initialize OpenTime
```

```
ReadDataLoop:
  Address=XOUT8:GOSUB DataIn              'Read in X-Axis acceleration value
  XAccel=ReceiveData|($FF00*ReceiveData.BIT7)      'Sign extend the two's complement byte so
  IF ABS XAccel> ABS Xmax THEN Xmax=XAccel        ‘negative numbers can be properl
ydisplayed
                                          'Xmax stores the max value of acceleration of X-Axis
  Address=YOUT8:GOSUB DataIn              'Read in Y-Axis acceleration value
  YAccel=ReceiveData|($FF00*ReceiveData.BIT7)          'Sign extend the two's complement byte
so
  IF ABS YAccel> ABS Ymax THEN Ymax=YAccel         'negative numbers can be properly
displayed
                                          'Ymax stores the max value of acceleration of Y-Axis
  Address=ZOUT8:GOSUB DataIn              'Read in Z-Axis acceleration value
  ZAccel=ReceiveData|($FF00*ReceiveData.BIT7)          'Sign extend the two's complement
byte so
  IF ABS ZAccel> ABS Zmax THEN Zmax=ZAccel          'negative numbers can be properly
displayed
                                          'Zmax stores the max value of acceleration of Z-Axis
  Cycles=Cycles+1                         'Cycles increases until Cycles reachs vertrefresh
  IF Control=1 THEN Function=Function+1             'If the button is pressed, change the value
of Function
```

```
ButtonLoop:                          'Wait unitl the button released
  IF Control=1 THEN                  'Show the result of OpenTime,when the button is pressed
    SEROUT 10, 84, [22, 12]          'Clear the screen
    PAUSE 5
    IF OpenTime<2 THEN               '1 is first time close box; 0 is test mode
    SEROUT 10, 84, ["Never open",13,13]   'Two 13 make sure only show the message once
    ELSE
    SEROUT 10, 84, ["Open ",DEC OpenTime-1," times",13,13]
    ENDIF
    PAUSE 50
    GOTO ButtonLoop
  ENDIF
  IF Function=0 THEN                 'LCD shows the max data
  XAccel=Xmax                        'Change the value to the max value
  YAccel=Ymax
  ZAccel=Zmax
  ENDIF
```

```
IF Cycles=Vertrefresh THEN                    'Start to show the value in LCD
SEROUT 10, 84, [22, 12]                       'Initialize LCD and clear the screen
PAUSE 5
SEROUT 10, 84, [" X:   Y:   Z:",13]
Decimal=XAccel+3                              'Display the X, Y, and Z accelerometer values
GOSUB Display                                 '"+3 +8 -2" are calibration value for different axis
Decimal=YAccel+8
GOSUB Display
Decimal=ZAccel-2
GOSUB Display
Cycles=0                                      'Reset Cycles
ENDIF
IF Photo=0 THEN                               '0: bright ; 1: dark
PAUSE 50
IF Photo=1 THEN OpenTime=OpenTime+1           'If the light changes from bright to dark,
OpenTime+1
ENDIF
GOTO ReadDataLoop                             'Back to read in data
```

DataOut:

```
LOW CSPin                                   'Pull chip select pin low to start transmission
SHIFTOUT DATAPin, CLKPin, MSBFIRST, [(Address|%1000000)<<1] 'Select register Address(first bit: 1 write/ 0 read)
SHIFTOUT DATAPin, CLKPin, MSBFIRST, [SendData]          'Write value to Address
HIGH CSPin                                  'End transmission
RETURN
```

DataIn:

```
LOW CSPin                                   'Pull chip select pin low to start transmission
SHIFTOUT DATAPin, CLKPin, MSBFIRST, [Address<<1]        'Select register Address
SHIFTIN DATAPin, CLKPin, MSBPRE, [ReceiveData]          'Read value from Address
HIGH CSPin                                  'End transmission
RETURN
```

Display:

```
IF  Decimal>32768 THEN                          'Judge the sign of value
  Decimal=-Decimal                              ‘Negative data has to be transformed before divided by 16
  IF (Decimal//16)=1 THEN                       'If the decimal part of the value is below 0.1, show the .06 directly
  SEROUT 10, 84,["-",DEC Decimal/16,".06 "]          '0.0625 is accuracy of the sensor
  ELSE                                          '16 means 1g in the data from the sensor of the mode 00
  SEROUT 10, 84,["-",DEC Decimal/16,".",DEC2 (Decimal//16)*100/16," "]
  ENDIF                                         'Show first two number of decimal part
ELSE
  IF (Decimal//16)=1 THEN                       'Show the positive data
  SEROUT 10, 84,[DEC Decimal/16,".06 "]
  ELSE
  SEROUT 10, 84,[DEC Decimal/16,".",DEC2 (Decimal//16)*100/16," "]
  ENDIF
ENDIF
RETURN
```

Data analysis

- We record maximum acceleration in different conditions

	Maximum acceleration(g)		
	X	Y	Z
Walking	-0.68	-1.68	1.50
Running	-2.12	-1.68	2.87
Bus	-0.62	-0.43	1.56
Subway	-1.00	-0.75	1.31
Shaking	-5.50	-2.87	4.75
Shaking inside box	-2.00	-1.06	2.93
Falling from 8cm	-1.50	-0.87	6.31

A Video on the bus