```
1   PROGRAM LSM303
2   VAR
3       A_Xaxis : INT ;
4       A_Yaxis : INT ;
5       A_Zaxis : INT ;
6       M_Xaxis : INT ;
7       M_Yaxis : INT ;
8       M_Zaxis : INT ;
9
10      LSM303_DATAIN1 : ARRAY [ 0 .. 40 ] OF BYTE ;
11      LSM303_DATAOUT1 : ARRAY [ 0 .. 40 ] OF BYTE ;
12      LSM303_DATAOUT_old1 : ARRAY [ 0 .. 40 ] OF BYTE ;
13
14      LSM303_DATAIN2 : ARRAY [ 0 .. 40 ] OF BYTE ;
15      LSM303_DATAOUT2 : ARRAY [ 0 .. 40 ] OF BYTE ;
16      LSM303_DATAOUT_old2 : ARRAY [ 0 .. 40 ] OF BYTE ;
17
18      CTRL_REG1_A : BYTE := 39 ;  //accelerometer
19
20      CRA_REG_M : BYTE := 16 ;    //mag
21      CRB_REG_M : BYTE := 32 ;    //mag
22      MR_REG_M : BYTE := 0 ;      //mag
23      M_Dir : REAL ;
24      //testa: REAL;
25      Normalized_M_X : REAL ;
26      Normalized_M_Y : REAL ;
27      Normalized_M_Z : REAL ;
28      M_X_real : REAL ;
29      M_Y_real : REAL ;
30      M_Z_real : REAL ;
31      A_X_real : REAL ;
32      A_Y_real : REAL ;
33      A_Z_real : REAL ;
34      Normalized_A_X : REAL ;
35      Normalized_A_Y : REAL ;
36      Normalized_A_Z : REAL ;
37      A_Roll : REAL ;
38      Zoffset : INT := 2000 ;
39      A_Roll_Filtered : REAL ;
40      A_Roll_Buf : ARRAY [ 0 .. 15 ] OF REAL := [ 0.01 , 0.02 , 0.03 , 0.04 , 0.05
    , 0.06 , 0.07 , 0.08 , 0.09 , 0.1 , 0.11 , 0.12 , 0.13 , 0.14 , 0.15 ] ;
41      A_Roll_RST : BOOL ;
42      A_Roll_Filtered1 : DINT ;
43      A_Roll_Filt1 : FILTER_I ;
44      A_Pitch : REAL ;
45      A_X_Filt : FILTER_I ;
46      A_X_Filtered : INT ;
47      A_Y_Filt : FILTER_I ;
48      A_Z_Filt : FILTER_I ;
49      A_Y_Filtered : INT ;
50      A_Z_Filtered : INT ;
51      A_Filt_Time : TIME := T#200ms ;
```

```
52          A_Roll_cos :  REAL ;
53          A_Roll_rad :  REAL ;
54          A_Roll_deg :  REAL ;
55          A_Pitch_Rad :  real ;
56          A_Pitch_Deg :  REAL ;
57          A_Roll_sin :  REAL ;
58          A_Pitch_cos :  REAL ;
59          A_Pitch_sin :  REAL ;
60          Heading_X :  REAL ;
61          Heading_Y :  REAL ;
62          Heading_Z :  REAL ;
63          Heading :  REAL ;
64          Heading_rad :  REAL ;
65          Heading_deg :  REAL ;
66          M_Ready :  INT ;
67      END_VAR
68
```

```
1       //Setup Number of Registers IN and OUT for I2C device (this is the LSM303 sensor
         on the IMU, looking at the accel data)
2       i2c_single_3 . REG_IN_START := 40 ;
3       i2c_single_3 . REG_OUT_START := 32 ;
4       i2c_single_3 . REGNUM_OUT := 1 ;
5       i2c_single_3 . REGNUM_IN := 6 ;
6
7       //Setup Number of Registers IN and OUT for I2C device (this is the LSM303 sensor
         on the IMU, looking at the accel data)
8       i2c_single_4 . REG_IN_START := 3 ;
9       i2c_single_4 . REG_OUT_START := 0 ;
10      i2c_single_4 . REGNUM_OUT := 3 ;            //111 = 7 first 3 reg
11      i2c_single_4 . REGNUM_IN := 7 ;             //111111 = first 6 reg
12
13      //Data from LSM303 sensor accelerometer
14      LSM303_DATAIN1 [ 0 ] := i2c_single_3 . DATAIN [ 0 ] ;
15      LSM303_DATAIN1 [ 1 ] := i2c_single_3 . DATAIN [ 1 ] ;
16      LSM303_DATAIN1 [ 2 ] := i2c_single_3 . DATAIN [ 2 ] ;
17      LSM303_DATAIN1 [ 3 ] := i2c_single_3 . DATAIN [ 3 ] ;
18      LSM303_DATAIN1 [ 4 ] := i2c_single_3 . DATAIN [ 4 ] ;
19      LSM303_DATAIN1 [ 5 ] := i2c_single_3 . DATAIN [ 5 ] ;
20
21      //Data from LSM303 sensor magnetometer
22      LSM303_DATAIN2 [ 0 ] := i2c_single_4 . DATAIN [ 0 ] ;
23      LSM303_DATAIN2 [ 1 ] := i2c_single_4 . DATAIN [ 1 ] ;
24      LSM303_DATAIN2 [ 2 ] := i2c_single_4 . DATAIN [ 2 ] ;
25      LSM303_DATAIN2 [ 3 ] := i2c_single_4 . DATAIN [ 3 ] ;
26      LSM303_DATAIN2 [ 4 ] := i2c_single_4 . DATAIN [ 4 ] ;
27      LSM303_DATAIN2 [ 5 ] := i2c_single_4 . DATAIN [ 5 ] ;
28      LSM303_DATAIN2 [ 6 ] := i2c_single_4 . DATAIN [ 6 ] ;
29
30      //LSM303 3 axis accelerometer
```

```
31      A_Xaxis := WORD_TO_INT ( Mem . PackBytesToWord ( LSM303_DATAIN1 [ 1 ] ,
        LSM303_DATAIN1 [ 0 ] ) ) ;
32      A_Yaxis := WORD_TO_INT ( Mem . PackBytesToWord ( LSM303_DATAIN1 [ 3 ] ,
        LSM303_DATAIN1 [ 2 ] ) ) ;
33      A_Zaxis := WORD_TO_INT ( Mem . PackBytesToWord ( LSM303_DATAIN1 [ 5 ] ,
        LSM303_DATAIN1 [ 4 ] ) ) - Zoffset ;
34      A_X_Filt ( X := REAL_TO_INT ( A_Xaxis ) , T := A_Filt_Time , Y => A_X_Filtered ) ;
35      A_Y_Filt ( X := REAL_TO_INT ( A_Yaxis ) , T := A_Filt_Time , Y => A_Y_Filtered ) ;
36      A_Z_Filt ( X := REAL_TO_INT ( A_Zaxis ) , T := A_Filt_Time , Y => A_Z_Filtered ) ;
37
38      A_X_real  := INT_TO_REAL ( A_X_Filtered ) / 16383.0 * ( 90.0 / ( 180.0 / 3.1415927 ) ) ;
39      A_Y_real  := INT_TO_REAL ( A_Y_Filtered ) / 16383.0 * ( 90.0 / ( 180.0 / 3.1415927 ) ) ;
40      A_Z_real  := INT_TO_REAL ( A_Z_Filtered ) / 16383.0 * ( 90.0 / ( 180.0 / 3.1415927 ) ) ;
41
42      //Roll calcs
43      A_Roll  := ( ATAN ( - A_X_Real / A_Z_Real ) ) * 180.0 / 3.1415927 ;
44      A_Roll_rad  := ( ATAN ( - A_X_Real / A_Z_Real ) ) ;
45      A_Roll_deg  := A_Roll_rad * 180.0 / 3.1415927 ;
46      A_Roll_cos  := COS ( A_Roll_rad ) ;
47      A_Roll_sin  := 1 - ( A_Roll_cos * A_Roll_Cos ) ;
48
49      //Pitch calcs
50      A_Pitch  := ( ATAN ( A_Y_Real / ( SQRT ( EXPT ( A_X_real , 2 ) + EXPT ( A_Z_real , 2 ) ) )
        ) ) * 180.0 / 3.1415927 ;
51      A_Pitch_Rad  := ( ATAN ( A_Y_Real / ( SQRT ( EXPT ( A_X_real , 2 ) + EXPT ( A_Z_real , 2 )
        ) ) ) ) ;
52      A_Pitch_Deg  := A_Pitch_Rad * 180.0 / 3.1415927 ;
53      A_Pitch_cos  := COS ( A_Pitch_Rad ) ;
54      A_Pitch_sin  := 1 - ( A_Pitch_cos * A_Pitch_cos ) ;
55
56      //LSM303 3 axis magnetometer
57      M_Ready := WORD_TO_INT ( Mem . PackBytesToWord ( 0 , LSM303_DATAIN2 [ 6 ] ) ) ;
58
59      IF M_Ready . 0 THEN
60          M_Xaxis := WORD_TO_INT ( Mem . PackBytesToWord ( LSM303_DATAIN2 [ 0 ] ,
        LSM303_DATAIN2 [ 1 ] ) ) ;
61          M_Zaxis := WORD_TO_INT ( Mem . PackBytesToWord ( LSM303_DATAIN2 [ 2 ] ,
        LSM303_DATAIN2 [ 3 ] ) ) ;
62          M_Yaxis := WORD_TO_INT ( Mem . PackBytesToWord ( LSM303_DATAIN2 [ 4 ] ,
        LSM303_DATAIN2 [ 5 ] ) ) ;
63          M_X_real  := INT_TO_REAL ( M_Xaxis ) ;
64          M_Y_real  := INT_TO_REAL ( M_Yaxis ) ;
65          M_Z_real  := INT_TO_REAL ( M_Zaxis ) ;
66      END_IF
67
68      Heading_X := M_X_real * A_Pitch_Cos + M_Y_real * A_Roll_sin * A_Pitch_sin + M_Z_real *
        A_roll_cos * A_pitch_sin ;
69      Heading_Y := M_Y_real * A_roll_cos - M_Z_real * A_roll_sin ;
70      Heading_rad := ATAN2 ( ( Heading_Y * - 1 ) , Heading_X ) ;
71      Heading_deg := Heading_rad * 180.0 / 3.1415927 ;
72
```

```
73      IF M_Yaxis > 0 THEN
74          M_Dir := 90.0 - (ATAN(M_X_real / M_Y_real)) * 180.0 / 3.1415927 ;
75      END_IF ;
76
77      IF M_Yaxis < 0 THEN
78          M_Dir := 270.0 - (ATAN(M_X_real / M_Y_real)) * 180.0 / 3.1415927 ;
79      END_IF ;
80
81      IF M_Yaxis = 0 AND M_Xaxis < 0 THEN
82          M_Dir := 180.0 ;
83      END_IF ;
84
85      IF M_Yaxis = 0 AND M_Xaxis > 0 THEN
86          M_Dir := 0.0 ;
87      END_IF
88
89      //Add the location declination. 13deg 38 min for Antioch or 13.633 for true
        north
90      M_Dir := M_Dir + 13.633 ;
91
92      //Control value for LSM303 sensor turning on X,Y,Z accelerometer
93      LSM303_DATAOUT1[0] := CTRL_REG1_A ;
94
95      //Control value for LSM303 sensor turning on X,Y,Z magnetometer36
96      LSM303_DATAOUT2[0] := CRA_REG_M ;
97      LSM303_DATAOUT2[1] := CRB_REG_M ;
98      LSM303_DATAOUT2[2] := MR_REG_M ;
99
100     //Ctrl data for LSM303 accelrometer sensor 39=ON
101     //Write the data to the output registers on change only
102     IF LSM303_DATAOUT_old1[0] <> LSM303_DATAOUT1[0] THEN
103             i2c_single_3.DATAOUT[0] := LSM303_DATAOUT1[0] ;
104             LSM303_DATAOUT_old1[0] := LSM303_DATAOUT1[0] ;
105     END_IF
106
107     //Ctrl data for LSM303 magnetometer sensor 16=15 hz
108     //Write the data to the output registers on change only
109     IF LSM303_DATAOUT_old2[0] <> LSM303_DATAOUT2[0] THEN
110             i2c_single_4.DATAOUT[0] := LSM303_DATAOUT2[0] ;
111             LSM303_DATAOUT_old2[0] := LSM303_DATAOUT2[0] ;
112     END_IF
113
114     //Ctrl data for LSM303 magnetometer sensor 32
115     //Write the data to the output registers on change only
116     IF LSM303_DATAOUT_old2[1] <> LSM303_DATAOUT2[1] THEN
117             i2c_single_4.DATAOUT[1] := LSM303_DATAOUT2[1] ;
118             LSM303_DATAOUT_old2[1] := LSM303_DATAOUT2[1] ;
119     END_IF
120
121     //Ctrl data for LSM303 magnetometer sensor 36=ON
122     //Write the data to the output registers on change only
```

```
123     IF  LSM303_DATAOUT_old2 [ 2 ]  <>  LSM303_DATAOUT2 [ 2 ]  THEN
124             i2c_single_4 . DATAOUT [ 2 ] := LSM303_DATAOUT2 [ 2 ] ;
125             LSM303_DATAOUT_old2 [ 2 ] := LSM303_DATAOUT2 [ 2 ] ;
126     END_IF
127
```