Stephen Hall and Razik Ahmed
TA: Harshad Desai

Lab 11 Report

A) Objectives
- **Overview**

  - **Objective**: To desgin, layout, construct, and test an embedded system.

  - **Roles and Responsibilities**:  Razik will do everything related to software, which includes the drivers, test code, and final game code. Stephen will do the hardware, which includes designing the printed circuit board, modifying the box, ordering parts, and soldering.  The clients are people that are bored of board games, people who want to play Battleship without al the hassle of keeping track of the pegs and ships.

- **Function Description**

  - **Functionality**: To play Battleship against a computer.

  - **Performance**:  Current will be determined using the bench power supply which will help decide the battery. Initial breadboarding with the DP512 suggests that the system will take around 50 mA with 120 mA spikes.

  - **Usability**: There will be two different modules each with a C32 microcontroller powered by a battery, 128 x 64 pixel graphical LCD screen, six buttons for  user input, 6 LEDs to signify a hit, and a speaker to play sound. A switch will also be on the outside of the box to turn power from the battery on or off. The two modules will be connected via a serial cable.

- **Deliverables**

  - **Reports**: The reports for Labs 8 and 11 will be written.

**Outcomes**: Objectives, hardware and software design, and measurement data for Lab 8 and Lab 11

B) Hardware Design
Schmatic Design is on page 3.
C) Software Design
The software initializes all the components first. After the game is initializied, the main goes into a do nothing for loop. The game operates on a finite state machine. The states are changed when an input capture interrupt triggers. Once the input capture is handled, the do nothing loop takes over again. This way, the power usage is dropped when nothing is being input. Some states advance after a certain

amount of time which is handled with a busy wait.Six of the IC/OC interrupts are used for switch interrupts. One OC interrupt is used for switch debouncing and the other OC is used for the music.
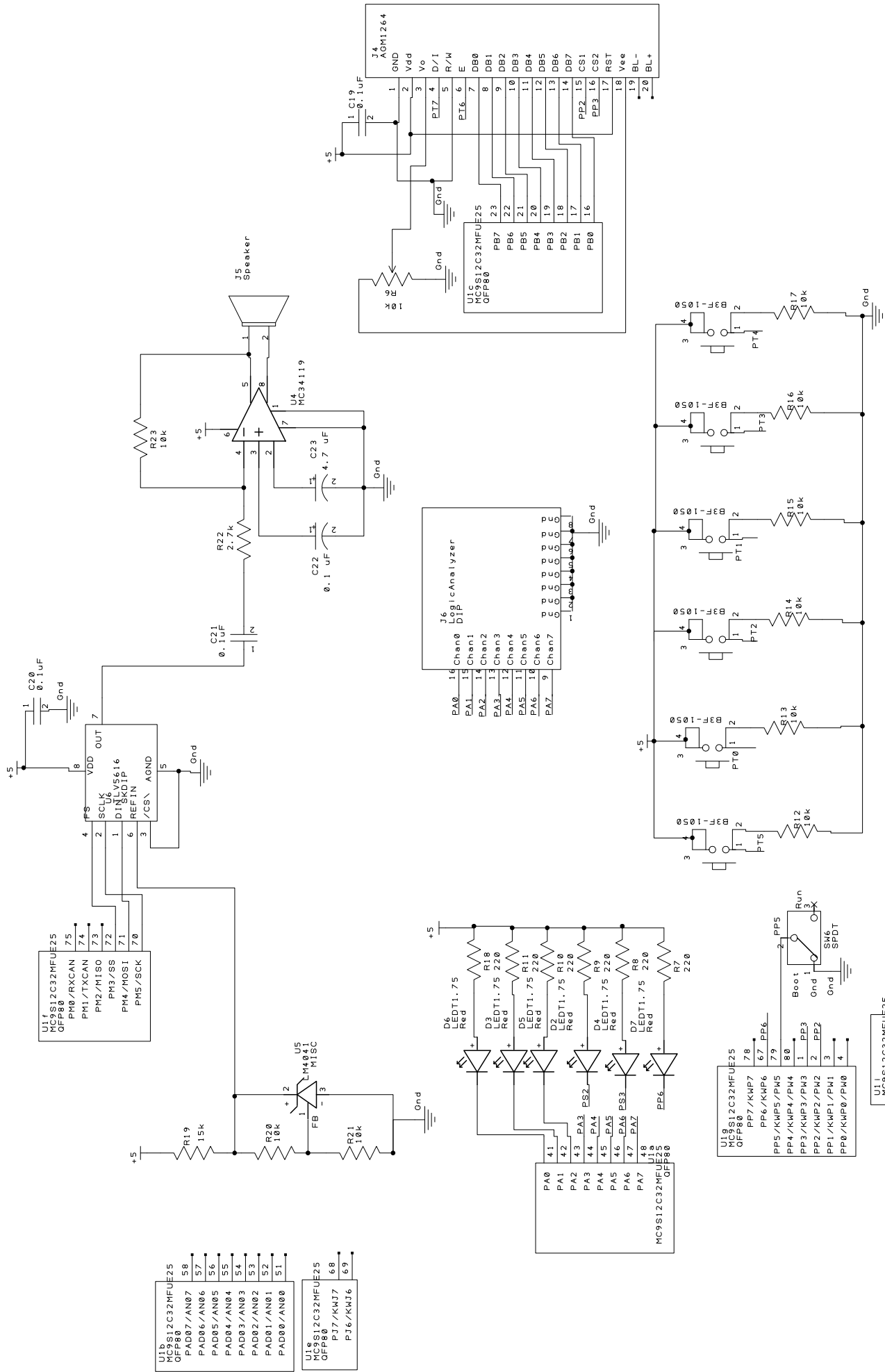
D) Measurement Data

Three test points were designed into the board to allow easy checks that there is 5 volts into the chip, 3.3 volts into the Xbee, and 2.5 volts into the DAC chip. A green LED is also on the board to tell if the power switch is on or off. We found that the current requirement for our system is 42 mA, so with a 9 volt battery that has 1200 mAhr our system will last 28.5 hours.

E) Analysis and Discussion (1 page maximum)

Once we received the board, we soldered it quickly so that we could ahve more time to test it. One problem we found was that the power pins are labeled red and black but they are backwards. After we changed those, all of our voltages were fine. The green power LED came on, the 3.3 V line was 3.28 V, the 2.5 V was 2.49 V, and the 5 V line was 4.96 V. Since everything was good in those repsects, we continued to test the code on the breadboarded version before porting DP512 code to C32 code. Initially, we wanted to have one module be able to talk to another by either the SCI port or the Xbee. We soon found out that our serial port didn't work correctly. We tried outputting 0x55 to the serial port at 9600 baud rate. On the scope we saw 0x55 but at 1200. So we changed the registers to multiply the baud rate by 8. Instead of getting 9600 on the next test, we got 5500 so we decided not to use the serial port anymore. We then focused only on single player mode.

We also found out that we have a problem with programming. Although we flashed the BDM, we were unable to to program without it. We could load a program only if both the serial port and the BDM were connected. If one or the other was not connected, the CodeWarrior wouldn't be able to find the board. Luckily our programs stayed in ROM so we just made sure to have a BDM whenever we programmed.

After all these problems, we worked on the box and porting the code. In the end we got single player working. The LCD would display the board. Six switches were inputs for up, left, down, right, select, and back. When an attack was made, the speaker would output a doppler-like whistle. If the attack was a hit, an explosion would play, otherwise nothing. If your attack hit, the six LEDs would flash, but this would not occur if an opponent hit you. A power switch was at the top for turning power on and off. Overall, we tried to make our box look as clean as possible. The holes were drilled in pre-determined spots and the squares were dremeled out so that everything fit perfectly. In the end everything worked well, besides the serial port.
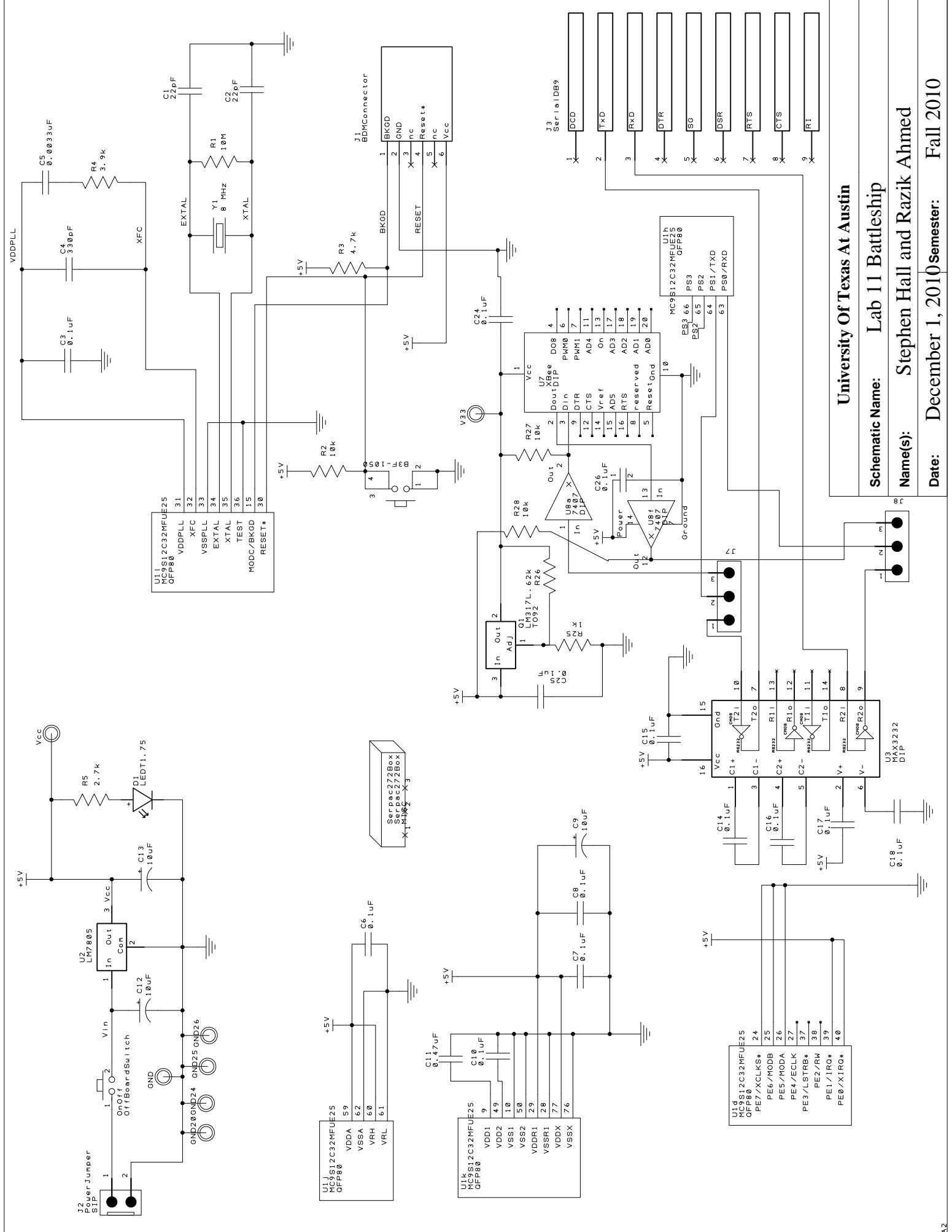
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| | |
|---|---|
| **Schematic Name:** | Lab 11 Battleship |
| **Name(s):** | Stephen Hall and Razik Ahmed |
| **Date:** | December1, 2010  **Semester:**  Fall 2010 |

J4
AGM1264
GND
Vdd
Vo
D/I
R/W
E
DB0
DB1
DB2
DB3
DB4
DB5
DB6
DB7
CS1
CS2
RST
Vee
BL-
BL+

C19
0.1uF
+5

PT7
PT6

U1c
MC9S12C32MFUE25
QFP80
PB7 23
PB6 22
PB5 21
PB4 20
PB3 19
PB2 18
PB1 17
PB0 16

PP2 15
PP3 16

Gnd

R6
10k
Gnd

J5
Speaker

U4
MC34119
R23
10k
+5
R22
2.7k
C23
4.7 uF
C22
0.1 uF
Gnd
C21
0.1uF

C20
0.1uF
Gnd

U6
TLV5616
DIP
VDD
OUT
FS
SCLK
DIN
REFIN
/CS
AGND
+5
Gnd

U1f
MC9S12C32MFUE25
QFP80
PM0/RXCAN 75
PM1/TXCAN 74
PM2/MISO 73
PM3/SS 72
PM4/MOSI 71
PM5/SCK 70

U5
LM4041
MISC
R19 15k
R20 10k
R21 10k
+5
Gnd
FB

J6
LogicAnalyzer
DIP
Chan0 16
Chan1 15
Chan2 14
Chan3 13
Chan4 12
Chan5 11
Chan6 10
Chan7 9
Gnd

PA0
PA1
PA2
PA3
PA4
PA5
PA6
PA7

PT4
B3F-1050
R17 10k
Gnd

PT3
B3F-1050
R16 10k

PT1
B3F-1050
R15 10k

PT2
B3F-1050
R14 10k

PT0
B3F-1050
R13 10k
+5

PT5
B3F-1050
R12 10k

+5
D6 LED1.75 Red
R18 220
D3 LED1.75 Red
R11 220
D5 LED1.75 Red
R10 220
D2 LED1.75 Red
R9 220
D4 LED1.75 Red
R8 220
D7 LED1.75 Red
R7 220
PS2
PS3

U1d
MC9S12C32MFUE25
QFP80
PA0 41
PA1 42
PA2 43
PA3 44
PA4 45
PA5 46
PA6 47
PA7 48

Run
SW6
SPDT
PP5
Boot
Gnd

U1g
MC9S12C32MFUE25
QFP80
PP7/KWP7 78
PP6/KWP6 67
PP5/KWP5/PW5 79
PP4/KWP4/PW4 80
PP3/KWP3/PW3 1
PP2/KWP2/PW2 2
PP1/KWP1/PW1 3
PP0/KWP0/PW0 4
PP7
PP6
PP3
PP2
PP6

U1i
MC9S12C32MFUE25
QFP80
PT7/IOC7 14 PT7
PT6/IOC6 13 PT6
PT5/IOC5 12 PT5
PT4/IOC4/PW4 11 PT4
PT3/IOC3/PW3 8 PT3
PT2/IOC2/PW2 7 PT2
PT1/IOC1/PW1 6 PT1
PT0/IOC0/PW0 5 PT0

U1b
MC9S12C32MFUE25
QFP80
PAD07/AN07 58
PAD06/AN06 57
PAD05/AN05 56
PAD04/AN04 55
PAD03/AN03 54
PAD02/AN02 53
PAD01/AN01 52
PAD00/AN00 51

U1e
MC9S12C32MFUE25
QFP80
PJ7/KWJ7 68
PJ6/KWJ6 69

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