



G12 Racer Game User Manual

Version 1.2

1.1 Introduction

Welcome to the G12 Racer Game User Manual. This manual describes how to setup and play the G12 Racer Game on your Atmel AVR board. This game was designed to work on the ATmega64 microcontroller but is compatible with a variety of microcontrollers from Atmel.

Inside this manual you will find instructions on how to wire up your AVR board, game rules and limitations as well information on how the hardware interacts with the game program.

1.2 Version

This is version 1.2 of the G12 Racer game which extends on the features of the previous version by adding a new shield powerup to the game. Each revision of the game contains significant game improvements.

1.3 Developers

This game was developed and tested by:

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2.1 Connections

In order to be able to play the G12 Racer Game, you will need to wire up your AVR board based on the connections (see **Figure 2.1.1**). Note that you may swap certain ports used by swapping connections and changing all references to PORTX, PINX and DDRX in the code to PORTY, PINY and DDY respectively where X represents the old port and Y represents the new port. Note that only connections with an asterisk (*) label in the connection list can be altered like this.

For full functionality, your AVR board must support a 2 line LCD display, a 10 light LED display, a numpad (numbered keypad), a motor with PWM support and two push buttons.

CONNECTIONS:

Inputs on the left hand side are connected (denoted by →) to ports on the right hand side.

- LCD D0-D7 → PC0-PC7 *
- LCD BE-RS → PB0-PB3 *
- KEYPAD R0-R3 → PA0-PA3 *
- KEYPAD C0-C3 → PA4-PA7 *
- LED0 - LED3 → PF0-PF3 *
- LED4 - LED9 → PE2-PE7 *
- PB0 → PD0 (INT0)
- PB1 → PD1 (INT1)
- MOT → PB4 (OCR)

Figure 2.1.1 – G12 Racer Connections

A visual colour coded representation has also been provided to assist you in connecting your board.

Board used below is the target ATmega64 board.

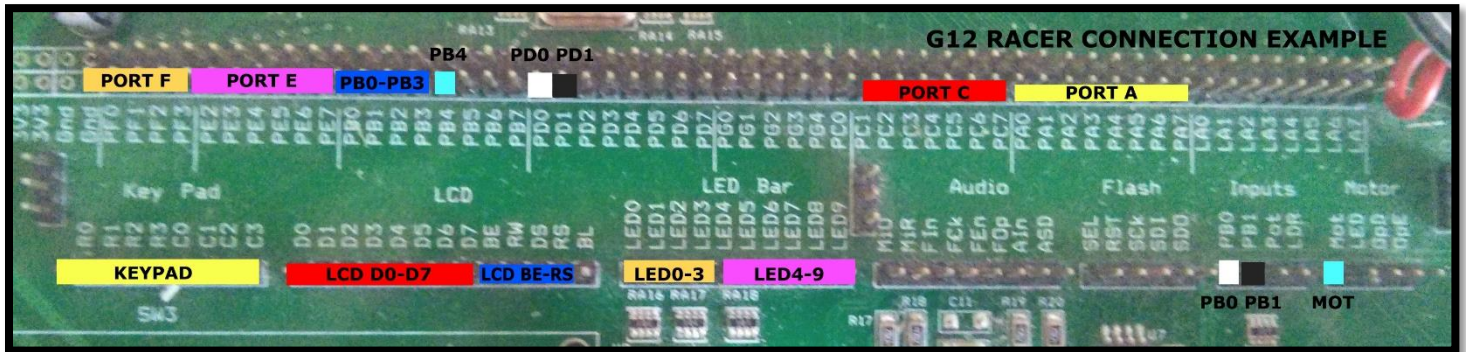


Figure 2.1.2 – G12 Racer Connection Example on ATmega64 Board

3.1

Interface, Gameplay and Rules

The G12 Racer Game is easy to learn and fun to play. The main objective of the game is to survive for as long as possible and obtain the most amount of points. Play as a group to try and beat your friend's high scores or play solo to see if you can beat those rapid speed levels.

3.2

Interface

A simple but effective interface is used in the game. This interface is represented by the boxes below.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
TOP	L	:	3		C	:	3		c				Ä			
BOT	S	:		1	3	3	7				Ä			S	ω	

Figure 3.2.1 – Example LCD Game View at some stage in game

There are a maximum of 32 characters which can be displayed on the LCD screen on this two line display at any given time. 16 characters occupy the first row while 16 characters occupy the second row. These are labelled on **Figure 3.2.1**.

Game Information Area

The first 8 characters in top row and bot row and reserved for displaying important game information.

On the first row, the level number and number of cars (lives) are displayed. There are 2 spots available for the number of levels and level 99 is theoretically reachable. The level is displayed on the most left character position if the level number is a single digit or across both characters if the level number is two digits.

The number of cars (lives) will always be a single digit, in fact it only decreases from its initial value.

The second row, the current score is displayed. The theoretical maximum value for the score is 65535 due to reasonable design choices. This score is extremely unlikely to be reached due to the extreme difficulty of levels post level 10.

The 8th character in the top row and bot row is a vertical line character. This separates the important game information area from the game play area.

Game Play Area

The game play area occupies the remaining 8 characters on both rows. In this area, different characters are displayed for different entities.

These entities and their corresponding characters are:

- c – Moveable car (player)
- ¢ – Moveable car with shield powerup equipped (player)
- Ä – Obstacle/Monster
- S – Score boost powerup (collectable)
- ω - Shield powerup (collectable)
- * - Crashed/Broken car
- ‘ ‘ – A space or empty character symbolises ‘walkable’ terrain

There is only 1 player displayed at any given time but there can be multiple instances of other entities.

Message Screens

After a hard reset (before the initial game interface is shown), the games title and version is flashed on and off the screen for a short duration before the game starts.



Figure 3.2.2 – Intro Message Screen

After a game is over, the final score is displayed on a game over screen indefinitely until a user soft or hard resets the game.



Figure 3.2.3 – Game over message screen

3.3

Gameplay and Rules

Initial Game State

A game begins with the player starting in the top left position at level 1 with 3 cars (lives). There are no obstacles or powerups in the game area initially and the score is set to 0.

This initial state is shown below:

L	:	1		C	:	3		c							
S	:					0									

Figure 3.3.1 – Initial LCD Game View

This initial state is displayed on the LCD for a short duration before obstacles and powerups begin 'spawning'.

TimeStep

After a certain duration of time, a new non-player entity is spawned in the last character spot in the top row or bot row (that is, the most right position) only if the last column contained no obstacles. Otherwise, no entity is spawned. This duration of time is known as the time step. After each time step, the game state is updated and all non-player entities (obstacle, score powerup and shield powerup) as well as empty spots are moved one position to the left.

The time step duration is based on the current level. Refer to the below table for time step durations:

Level	Time Step Duration (s)
1	1.00
2	0.90
3	0.80
4	0.70
5	0.60
6	0.50
7	0.25
8	0.10
9 (and onwards)	Half of previous level

Figure 3.3.2 – Table of Level to Time Step Duration correlation

Entity Spawn Chance

The spawned entity type is determined by chance. The below table shows the chance of each entity type being spawned after each time step if there were no obstacles in the previous column.

Entity Type/Location	Chance of Spawning (%)
Shield Powerup (top row)	1
Shield Powerup (bot row)	1
Score Powerup (top row)	4
Score Powerup (bot row)	4
Obstacle (top row)	25
Obstacle (bot row)	25
Nothing (in either row)	40

Figure 3.3.3 – Table of Entity Type to Percentage Chance of Spawning correlation

PowerUps

The score and shield powerups disappear half way through the game area so players must risk playing closer to the spawn position of entities in order to obtain these powerups.

Each powerups functionality is detailed below:

Score Powerup

The score powerup (S) gives the player bonus points. The boost is calculated to be $10 * level$ bonus points. This is the main source of points and users should attempt to collect all the score powerups they can, especially at earlier levels with lower time steps.

Shield Powerup

The shield powerup (ω) buffs your car with a protective shield, changing its appearance from a 'c' to 'c' with a shield symbol to indicate that the player has the shield equipped. Upon crashing with an obstacle, a player with an equipped shield will have their shield destroyed as opposed to their car (life). This removes the obstacle from the game (without providing any obstacle removal points) and reverts the car back into a normal car 'c'.

Shields do not stack (that is you can only have one shield at any given time). Collecting another shield powerup with the shield powerup already equipped gives the player bonus points equivalent to **level** points.

Shields are very useful in that they are not destroyed if the player progresses to the next level. Thus wise players will keep their shield intact for as long as possible to obtain bonus points from collecting more shields whilst allowing all obstacles to remain intact so that they provide points once they leave the game area.

Car Crashing and Levelling System

If a car collides with an obstacle, a car (life) is lost, the explosion character is shown for a short duration and the level restarts. Any points obtained in a failed level is still retained.

Each level lasts for a duration of 30 seconds. After this duration of time, all entities are reset to their initial state and the next level begins. Level 99 is theoretically reachable and is the maximum level although it is extremely unlikely that any user would ever reach these higher levels unless if they skip levels.

Once all lives are lost, the game is over and the final score is displayed on a separate screen. Users must then soft reset or hard reset to begin a new game.

4.1

Controls and Modules

Car Movement (Keypad)

Users are able to control the player (car) by using the keypad. The car is moved with the 2, 4, 6 and 8 buttons of the keypad corresponding to the actions UP, LEFT, RIGHT and DOWN respectively.

Movement is restricted by the game area meaning that the car will always be contained in the game area.

Restart Game, Restart Level and Next Level (Push Buttons)

Push buttons are used to control the flow of the game. Pressing Push Button 0 will soft reset the game so that it begins in the initial game state at level 1 with 3 lives. The soft reset does not display the initial introduction message unlike a hard reset so that users can restart games quickly.

Pressing Push Button 1 a single time will restart the current level with all entities in their initial state. Any points obtained thus far in the level prior to restarting the level are still retained. This functionality was added to allow users to practice the tougher levels.

Pressing Push Button 2 twice in a short duration of time (double pressing) will skip the current level and start the game in the initial state at this new level. Once again, this functionality allows users to practice the later more difficult levels without playing the earlier and easier levels.

Current Score Display (LED)



The LED bar graph always displays the lowest 10 bits of the 16bit score. This means that the LED is capable of displaying binary from 0 to 1023 (2^{10}). Once this score is surpassed, the LED simply overflows. Due to the nature of the game, the LED will begin filling up faster and faster at later levels and is a good indication of the current amount of points and intensity of the current level.

Figure 4.1.1 – LED displaying score of 476 in binary.

Car Crashing Side-Effects (Motor)

Upon crashing into an obstacle, the motor will run at 70rps for 2 seconds. This represents vibration and is achieved using PWM.