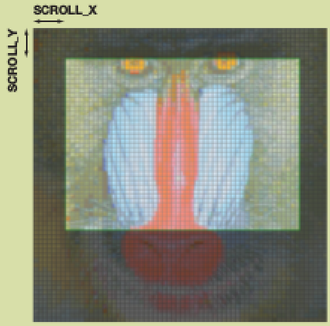
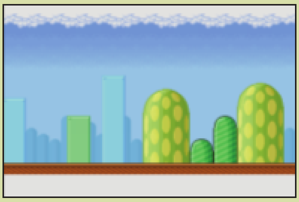
GAMEDUINO quick r

screen

Screen RAM is a grid of 64×64 bytes, each byte is a single character index. This byte controls the characte image and palette used for that 8×8 pixel cell. The tot size of the background screen is 512×512 pixels, but only 400×300 pixels are visible. The **SCROLL_X** and **SCROLL_Y** registers control the position of this 400×300 pixel window within the larger screen area.



code sample: **scroll**



memory map

Gameduino has 32 kbytes of memory, organized into different functions. The background section controls background character graphics. The sprite section controls the foreground sprite graphics.

background	0x0000	0x0FFF	64x64 character screen
	0x1000	0x1FFF	character data 256 characters of 8x8 pixels
	0x2000	0x27FF	character palettes 256 characters of 4 colors
control registers	0x2800	0x2FFF	control registers collision RAM
sprites	0x3000	0x37FF	sprite control 256x4 bytes
	0x3800	0x3FFF	sprite palette 4 palettes of 256 colors
	0x2800	0x7FFF	sprite images 64 images of 16x16 bytes

registers

Registers control some simple functions of the Gamed

address	bytes	name
0x2800	1	IDENT
0x2801	1	REV
0x2802	1	FRAME
0x2803	1	VBLANK
0x2804	2	SCROLL_X
0x2806	2	SCROLL_Y
0x2808	1	JK_MODE
0x280A	1	SPR_DISABLE
0x280B	1	SPR_PAGE
0x280C	1	IOMODE
0x280E	2	BG_COLOR
0x2810	2	SAMPLE_L
0x2812	2	SAMPLE_R
0x281E	2	SCREENSHOT_Y
0x2840	32	PALETTE 16A
0x2860	32	PALETTE 16B
0x2880	8	PALETTE 4A
0x2888	8	PALETTE 4B
0x2900	256	COLLISION
0x2A00	256	VOICES
0x2B00	800	SCREENSHOT

sprite palette select

reference

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character
 The total
els, but
_**X** and
is
n area.

characters

Characters are 8×8 grids of pixels, defined by the values in the character data and palette RAMs. The character data RAM holds the 64 pixels of the character image, encoded using two bits per pixel. The hardware uses these two bits to look up the final color in the character's 4-entry palette.

For example, a character with a palette of blue, yellow, red and white might appear as shown below. In the left-hand square, the pixel values 0–3 are shown. In the middle square, these pixel values in binary are listed. In the right hand column are the hex values, as they appear in memory for this character.

0	1	1	1	1	1	1	1
0	1	2	2	2	1	1	1
1	1	2	2	2	1	1	0
0	1	2	3	3	3	3	3
1	1	1	1	2	1	1	1
0	1	1	1	2	1	1	1
1	1	1	1	2	1	1	1
0	1	1	1	2	1	1	1

00	01	01	01	01	01	01	01
00	01	10	10	10	01	01	01
01	01	10	10	10	01	01	00
00	01	10	11	11	11	11	11
01	01	01	01	10	01	01	01
00	01	01	01	10	01	01	01
01	01	01	01	10	01	01	01
00	01	01	01	10	01	01	01

15	55
1A	95
5A	94
1B	FF
55	95
15	95
55	95
15	95

e Gameduino. Gameduino is little-endian, so 16-bit registers have their lower 8 bits at the lower address in memory.

me	description	access	reset value
NT	Gameduino identification—always reads as 0x6D	r	0x6d
EV	Hardware revision number. High 4 bits are major revision, low 4 bits are minor	r	0x10
ME	Frame counter, increments at the end of each displayed frame	r	0
ANK	Set to 1 during the video blanking period	r	0
LL_X	Horizontal background scrolling register, 0–511	r/w	0
LL_Y	Vertical background scrolling register, 0–511	r/w	0
ODE	Sprite collision class mode enable 0–1	r/w	0
SABLE	Sprite control: 0 enable sprite display, 1 disable sprite display	r/w	0
PAGE	Sprite page select: 0 display from locations 0x3000–0x33FF, 1 from 0x3400–0x37FF	r/w	0
ODE	Pin 2 mode: 0=disconnect, 0x46=flash enable, 0x4A=coprocessor control	r/w	0
OLOR	Background color	r/w	0
PLE_L	Audio left sample value, 16 bit signed -32768 to +32767	r/w	0
LE_R	Audio right sample value, 16 bit signed -32768 to +32767	r/w	0
SHOT_Y	Screenshot line select 0–299	r/w	0
TE 16A	16-color sprite A palette	r/w	0000 (black)
TE 16B	16-color sprite B palette	r/w	0000 (black)
TE 4A	4-color sprite A palette	r/w	0000 (black)
TE 4B	4-color sprite B palette	r/w	0000 (black)
SION	Collision RAM	r	0
CES	Audio voice controls	r/w	0
NSHOT	Screenshot line RAM	r	0

sprite rotate

sprite control

Gameduino has 256 hardware sprites: 16×16 pixel images that can appear anywhere on the screen. Sprites are drawn from back-to-front, so higher-numbered sprites cover up lower-numbered ones. Each sprite's appearance is controlled by a 32-bit word:

31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

C	IMAGE	Y	PAL	ROT	X

X X coordinate, 0-511. 0 is the left edge of the screen, 399 is the right edge.

Y Y coordinate, 0-511. 0 is the top edge of the screen, 299 is the bottom edge.

IMAGE Spriteimageselect,0-63. Selects which source image the sprite uses.

PAL Sprite palette select, 4 bits. Controls how pixel data is turned into color.

ROT Sprite rotate, 3 bits. Rotates a sprite by quarter-turns.

C Collision class, 0 is J, 1 is K.

To hide a sprite park it off the screen by setting its Y coordinate to 400.

To make a large sprite draw several sprites together in a grid pattern. For example, four 16x16 sprites can be arranged to make a single 32x32 sprite.

To spin a sprite use the ROT field to rotate it, and use extra animation frames for finer rotations.

To animate a sprite you can

- change the IMAGE field
- change the PAL field to do simple color animation
- change the ROT field to apply flips and rotates of 90, 180 and 270 degrees
- load new data to the source image.

sprite palette select

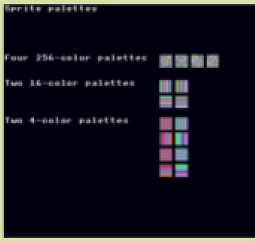
Each pixel of the sprite image is fetched and looked u list of colors. Gameduino gives you several palette op palette and a 4-color palette. Why not always use the the smaller palette options lets you squeeze more ima sprite image RAM can hold one 16x16 sprite image in 4-bit mode (with a 16 color palette), or four images in

3	2	1	0
0	0	P	
0	1	N	AB
1	N		AB

8–bit mode
Each byte indexes into 25

4–bit mode
The high (N=1) or low (N= index into 16-color palette

2–bit mode
Two bits from each byte (I index into 4-color palette



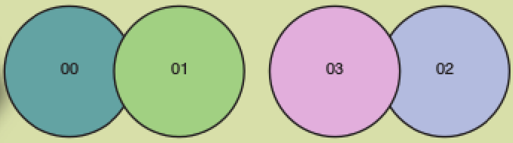
```
Sprite palettes

Four 256-color palettes
Two 16-color palettes
Two 4-color palettes
```

sprite collision detection

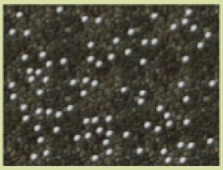
The Gameduino has a special memory area that you can use to detect when sprites overlap. As it draws the image, Gameduino keeps track of which pixels cover others, and writes the results into the collision RAM.

Each byte in the collision RAM corresponds with the same numbered sprite. If the sprite does not cover another then the byte's value is 0xFF. But if the sprite covers any part of another sprite, then the value is the number of the other sprite.

For example, if sprites 00–03 are arranged like this:



address	value	meaning
0x2900	FF	sprite 00 did not cover up any other sprite
0x2901	00	sprite 01 covered up some pixels from sprite 00
0x2902	FF	sprite 02 did not cover up any other sprite
0x2903	02	sprite 03 covered some pixels from sprite 02



code sample:
collision

ooked up in a sprite palette. This palette is a
alette options: a 256-color palette, a 16-color
use the 256-color palette? Because using
nore images into memory. 256 bytes of
mage in 256-color mode, two images in
ages in 2-bit mode (4 color palette).

s into 256-color palette, P

low (N=0) 4 bits from each byte
r palette A (AB=0) or B (AB=1)

h byte (N=3 is highest, N=0 is lowest)
palette A (AB=0) or B (AB=1)

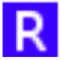
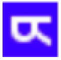
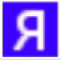
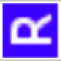
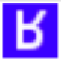
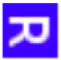
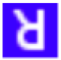
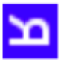
code sample: **palettes**

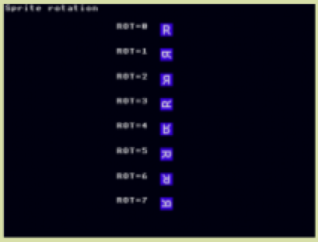
sprite rotate

Each sprite has a 3-bit ROT field that applies a simple rotation and flip to the sprite image.

2	1	0
Y flip	X flip	XY swap

Y flip flip the image top-to-bottom
X flip flip the image left-to-right
XY swap flip the image diagonally
By using these in combination, the sprite image can be rotated:

ROT	Y flip	X flip	XY swap	results
0	0	0	0	
1	0	0	1	
2	0	1	0	
3	0	1	1	
4	1	0	0	
5	1	0	1	
6	1	1	0	
7	1	1	1	



```
Sprite rotation
ROT=0
ROT=1
ROT=2
ROT=3
ROT=4
ROT=5
ROT=6
ROT=7
```

code sample: **rotation**

n

n use to
neduino
results

me
en the
another

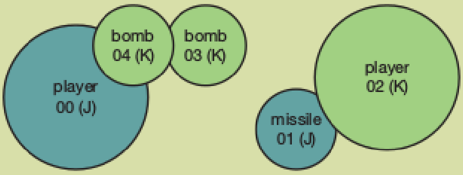
e
rite 00
e
e 02

sprite collision class

In a game you might have the following rules:

- when the player touches an enemy bomb, the player dies
- when a player's missile touches an enemy, that enemy dies.

Here is a typical in-game situation:



Notice that bomb 04 covers both bomb 03 and player 00. In this situation we're much more interested that bomb 04 is covering player 00. For this reason, the hardware has a mode JK_MODE where it ignores "friendly" collisions. In this mode, each sprite belongs a collision class J or K. Collision notifications only happen when a J sprite covers up a K sprite, or when a K sprite covers up a J sprite.

address	value	meaning
0x2900	FF	sprite 00 no collision
0x2901	FF	sprite 01 no collision
0x2902	01	sprite 02 covers some pixels from sprite 01
0x2903	FF	sprite 03 no collision
0x2904	00	sprite 04 covers some pixels from sprite 00

code sample:
jkcollision

colors

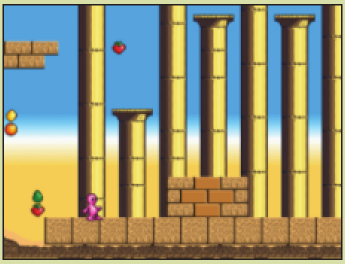
Gameduino stores colors in an ARGB1555 format:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
A	R					G					B				

Each color field red (**R**) green (**G**) and blue (**B**) has a range 0–31.
Gameduino is little-endian, so a color stored in two bytes stored starting at address is:

	7	6	5	4	3	2	1	0
address {	G_2	G_1	G_0	B_4	B_3	B_2	B_1	B_0
address+1 {	A	R_4	R_3	R_2	R_1	R_0	G_4	G_3

The **A** bit controls transparency. When A=1 the pixel is transparent and the other fields are ignored.
For sprites, transparent pixels show through the background layer. For the background layer, transparent pixels show BG_COLOR.



code sample:
bgcolor