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Program Library
User's Guide 2
Graphics Library

Doc. # ST-157-R1-092994

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Contents

VDP1 Library

1.0 VDP1 Basic Processing Guide

1.1 Objective

- Hides hardware-related processing such as VDP1 initialization, register operation, etc., to reduce the load on the application author.
- Because of differences in processing methods used to speed up applications, the basic processing library does not write commands to VRAM. The application has the VRAM addresses, so these can be controlled and written on the application side.
  (Writing to VRAM and VRAM control is supported by the expanded processing library.)

1.2 Explanation

Initial Processing

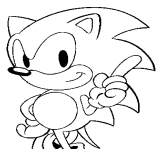
- Sets the frame buffer erase area, erase data for each frame change, and the TV mode.

V-BLANK Interrupt Processing Function

- SPR_WaitDrawEnd () is used in the V_BLANKVDP interrupt routine to check for VDP1 draw end.

1.3 Example of a Program Description

```
#include <machine.h>
#include “sega_spr.h”
#include “sega_scl.h”
#include “sega_int.h”

extern void vbStart (void);  /* V-BLANK IN Interrupt Routine    */
extern void vbEnd (void);    /* V-BLANK OUT Interrupt Routine   */

main()
 {
   Uint8    *vram;          /* VRAM Address Storage Area       */

   set_imask(0);            /* Enable Interrupt                */

   SCL_Vdp2Init();          /* Initialize scroll and priority  */
   SCL_SetPriority(SCL_SP0|SCL_SP1|SCL_SP2|SCL_SP3|SCL_SP4|
                   SCL_SP5|SCL_SP6|SCL_SP7,7);
   SCL_SetSpriteMode(SCL_TYPE1,SCL_MIX,SCL_SP_WINDOW);
   SPR_Initial(&vram);      /*Initialize Sprite                */

   INT_ChgMsk(INT_MSK_NULL, INT_MSK_VBL_IN | INT_MSK_VBL_OUT);
                            /* Disable V-BLANK Interrupt       */
   INT_SetFunc(INT_SCU_VBLK_IN, &vbStart);
                         /* Register V-BLANK IN Interrupt Routine*/
   INT_SetFunc(INT_SCU_VBLK_OUT, &vbEnd);
                         /* Register V-BLANK OUT Interrupt Routine*/
   INT_ChgMsk(INT_MSK_VBL_IN | INT_MSK_VBL_OUT, INT_MSK_NULL);
                            /* Enable V-BLANK Interrupt        */

   SCL_SetFrameInterval(2); /* Set the frame change interval to */
                            /* 2/60 seconds                    */

   for(;;) |
        memcpy(vram,command,sizeof(command));
                            /* Set the Sprite Command in VRAM  */

            ———             /* Set Scroll Data                 */

        SCL_DisplayFrame(); /* Wait for V-BLANK Interrupt      */
                            /* Display Sprite and Move Scroll  */
   }
}
```

- V-Blank Processing Routine (Separate source file from the main shown on previous page.) -

```
#include <machine.h>
#include “sega_spr.h”
#include “sega_scl.h”

#pragma interrupt(VbStart)
#pragma interrupt(VbEnd)

void VbStart(void)
{
   SCL_VblankStart(); /* V-Blank Start VDP Interrupt Processing */

            ————        /* Other V-Blank Start Processing       */
}

void VbEnd(void)
{
   SCL_VblankEnd();     /* V-Blank End VDP Interrupt Processing */
   ————                 /* Other V-Blank End Processing         */
}
```

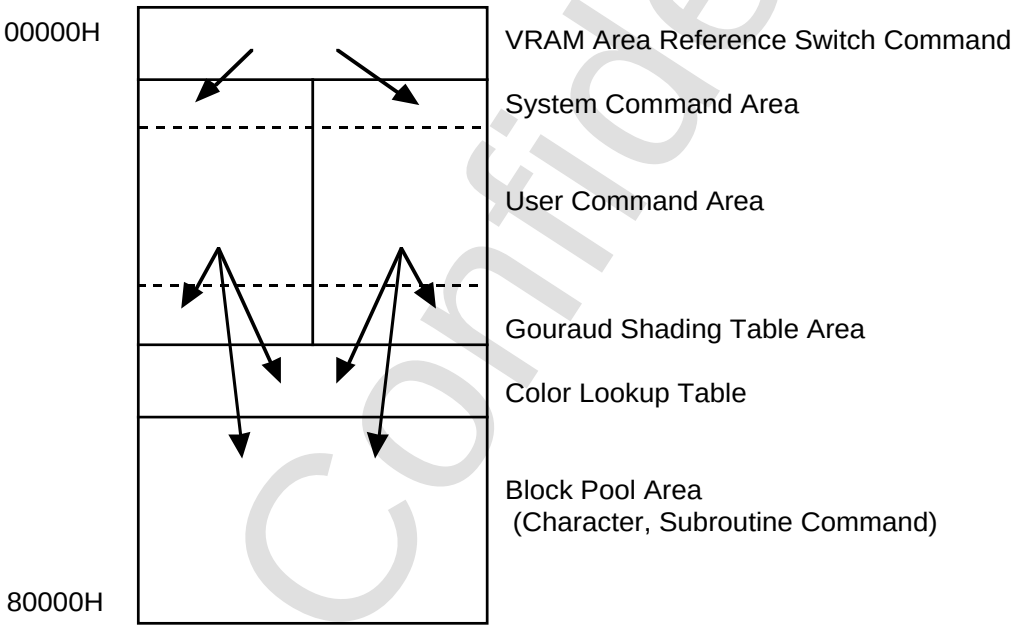
2.0 VDP1 Expanded Processing Guide

2.1 Objective

- Supports functions that were not included in the basic processing library such as VRAM management and writing sprite commands to VRAM.
- Executes a primitive sprite display command that corresponds to the sprite command.

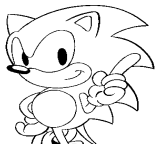
2.2 How to Manage the VRAM Area

The VRAM area (512Kbyte) is assigned as shown below.



Explanation of Each Area

- VRAM Area Reference Switch Command
  Sprite jump command that is used to match the VRAM area 0, 1 for frame change.
- System Command Area
  This area is used to open the access routine used to erase the frame buffer with polygon draw when the frame change interval is insufficient. Areas 0 and 1 are the same size.
- User Command Area
  Area where sprite commands organized from the top down through the various command set routines called from the SPR_2OpenCommand() to the SPR_2CloseCommand() routine. Areas 0 and 1 are the same size.



· Gouraud Shading Table Area
Area that stores the Gouraud shading table with 8 bytes for each entry and controls numbers starting at 0. Areas 0 and 1 are the same size.

· Color Lookup Table Area
Area that stores the Color Lookup table with 8 bytes for each entry and controls numbers starting at 0. Areas 0 and 1 are the same size. Areas 0 and 1 are referenced commonly.

· Block Pool Area
Area that is referenced by both command areas 0 and 1 and contains character data and sub-routine commands, etc. (Subroutine commands are currently not supported.) Character data is controlled starting at number 0. The assigning of character data, etc., to this area is dynamically acquired and released in 32 byte blocks.

The Assigned Size of Each Area

The size of each area is assigned as shown below; one block is 32 bytes.

Area Name	Blocks
VRAM Area Reference Switch Command	1
System Command Area	4x2
User Command Area	COMMAND_MAX x2
Gouraud Shading Table Area	(GOUR_TBL_MAX+3)/4x2
Color Lookup Table Area	LOOKUP_TBL_MAX
Block Pool Area	All remaining blocks

COMMAND_MAX : Maximum number of commands
GOUR_TBL_MAX : Maximum number of Gouraud shading tables
LOOKUP_TBL_MAX : Maximum number of lookup tables
These values are defined later in the VDP1 expanded processing work area definition macro.

Block Assign Algorithm Inside the Block Pool Area

- When Acquiring
Searches for a contiguous block that will hold the block that is being requested and assigns it the minimum area.

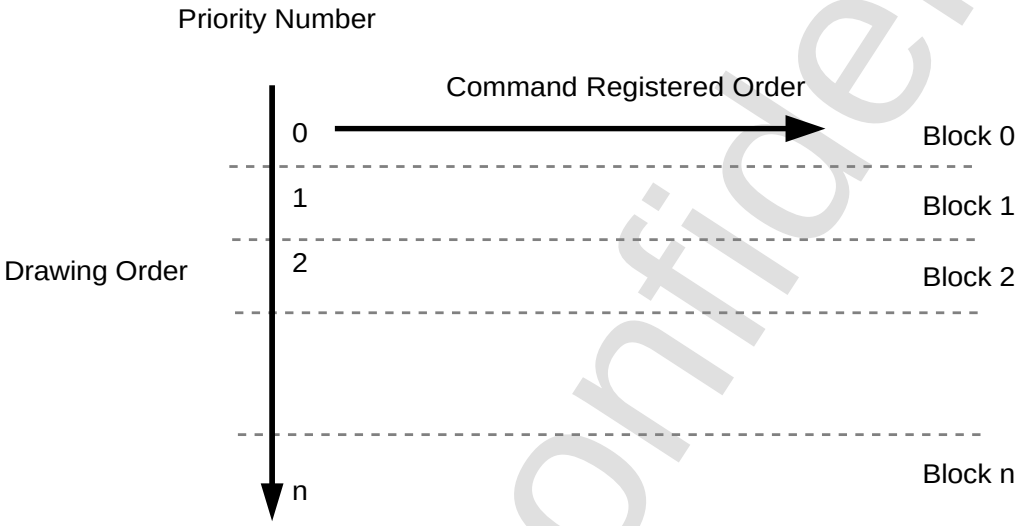
- When Releasing
Releases the designated block area. If there is an empty block next to the block being released, both blocks are combined to form a large empty block.

2.3 Drawing Order to the Sprite Command Frame Buffer

The drawing order can be set for each command by setting the draw priority value when the sprite command set routines below are called up.

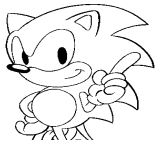
```
SPR_2LocalCoord() SPR_2SysClip() SPR_2UserClip() SPR_2line()
SPR_2polyLine()   SPR_2Polygon() SPR_2NormSpr()  SPR_2ScaleSpr()
SPR_2DistSpr()    SPR_2Cmd()
```

The draw priority number indicates the draw block number. Block number 0 is drawn first. Also, commands within the blocks are drawn in the order they were recorded.



The drawing order is set by calling up the SPR_2CloseCommand() or SPR_2FlushDrawPrty() routines. The control word jump and link settings in the command can be changed here.

The number of blocks in the draw order number control block are set in advance. It can be set in the 2D work area definition or the SPR_2OpenCommand () if the draw area is not to be attached.



2.4 Example of a Program Description

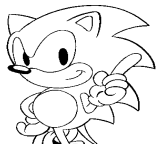
An actual example program in C language is shown below.

```
#include machine.h>
#define _SPR2_          /* Use Sprite Display Extended Library  */
#include “sega_spr.h”
#include “sega_scl.h”
#include “sega_int.h

#define COMMAND_MAX     512  /* Maximum commands                */
#define GOUR_TBL_MAX    512  /* Maximum Gouraud tables          */
#define LOOKUP_TBL_MAX  512  /* Maximum Lookup tables           */
#define CHAR_MAX        100  /* Maximum Characters              */
#define DRAW_PRTY_MAX 256    /* Maximum Draw Priority Blocks    */
SPR_2DefineWork(work2d, COMMAND_MAX, GOUR_TBL_MAX,
                        LOOKUP_TBL_MAX, CHAR_MAX)
                            /* Define 2D Work Area             */
extern void vbStart(void);   /* V-BLANK IN Interrupt Routine    */
extern void vbEnd(void);     /* V-BLANK OUT Interrupt Routine   */

main()
 {
      set_imask(0);          /* Enable Interrupt                */

   SCL_Vdp2Init();           /* Initialize Scroll and Priority  */
   SCL_SetPriority(SCL_SP0|SCL_SP1|SCL_SP2|SCL_SP3|SCL_SP4|
                   SCL_SP5|SCL_SP6|SCL_SP7,7);
   SCL_SetSpriteMode(SCL_TYPE1,SCL_MIX,SCL_SP_WINDOW);
   SPR_2Initial(&work2d);   /*Initialize 2D Sprite Display     */

   INT_ChgMsk(INT_MSK_NULL, INT_MSK_VBL_IN | INT_MSK_VBL_OUT);
                            /* Disable V-BLANK Interrupt       */
   INT_SetFunc(INT_SCU_VBLK_IN, &vbStart);
                       /* Register V-BLANK IN Interrupt Routine*/
   INT_SetFunc(INT_SCU_VBLK_OUT, &vbEnd);
                       /* Register V-BLANK OUT Interrupt Routine*/
   INT_ChgMsk(INT_MSK_VBL_IN | INT_MSK_VBL_OUT, INT_MSK_NULL);
                            /* Enable V-BLANK Interrupt        */

   for(;;) {
      SPR_2SetChar(...);    /* Set Character Data to VRAM      */
   }

    SPR_2FrameChgIntr(0xffff); /* Set the Frame Change Interval */
                               /* to Undefined                 */

   for(;;) {

            ———————      /* Set Scroll Data                   */

      SPR_2OpenCommand(SPR_2DRAW_PRTY_OFF);
                              /* Open Command Write            */
      SPR_2SysClip(0,&xy);    /* System Clip Area Command      */
      SPR_2LocalCoord(0,&xy); /* Local Coordinates Command     */
```

```
      SPR_2Polygon(...);      /* Each Type of Sprite Command    */
      SPR_2NormSpr(...);      /*
                              .
                              .
                              .

      SPR_2CloseCommand() ;  /* Close Command Write             */

      SCL_DisplayFrame() ;   /* Hold Interrupt V_BLANK          */
                             /* Display Sprite and Move Scroll  */
   }
}
```

- V Blank Process Routine (The main above is a separate source file) -

```
#include machine.h>
#include “sega_spr.h”
#include “sega_scl.h”

#pragma interrupt (VbStart)
#pragma interrupt (VbEnd)

void VbStart(void)
 {
   SCL_VblankStart();        /* VBlank start VDP Intrrpt. Process*/
            ———        /* Other VBlank Start Processes         */
 }

void VbEnd(void)
 {
   SCL_VblankEnd();          /* VBlank End VDP Interrupt Process */
            ———
 }
```

3.0 VDP1 3D Guide

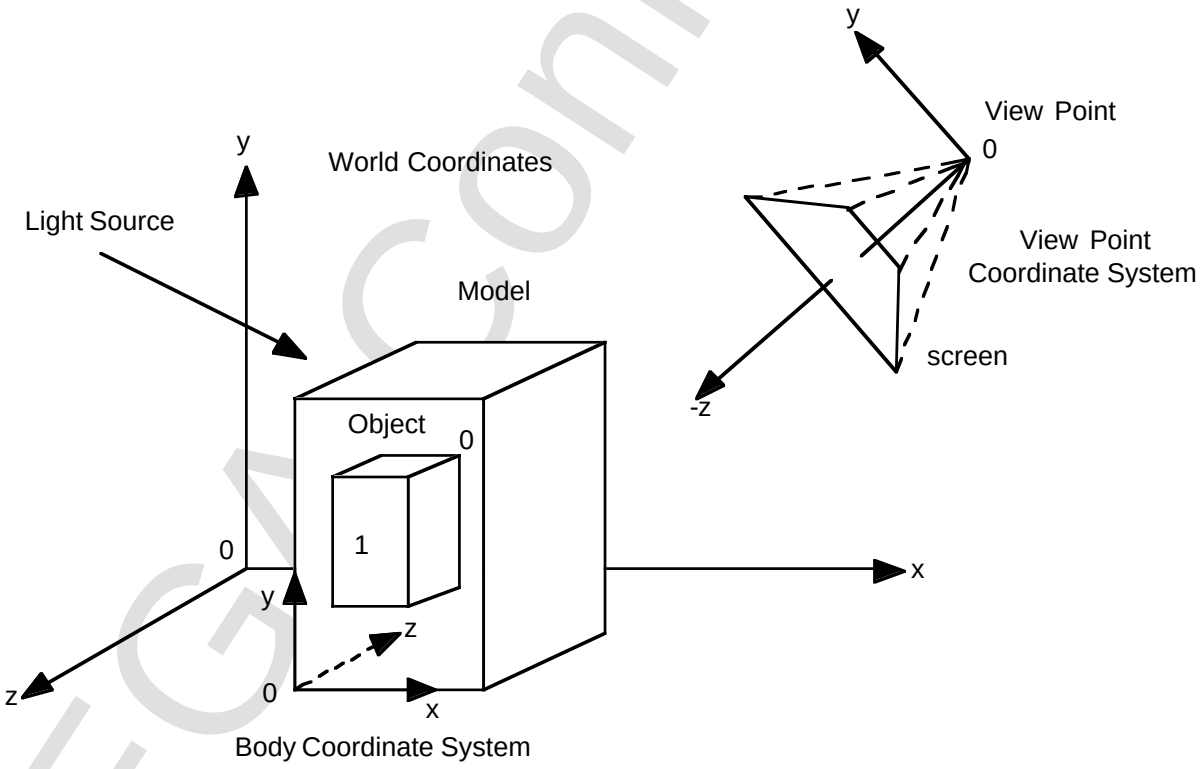
3.1 Objective

The purpose here is to use the VDP1 expansion processing library to display 3D sprites.

- Handles layers of connected models that consist of groupings of polygons.
- There is no need to understand the matrix calculations that accompany the movement of models or the objects within a model.
- The user application is made aware of the coordinate value of the point after world coordinates have been converted through the user call back routine.
- Texture mapping and sprite coloring during display can also be applied to polygons.
- Can be matched with 2D sprites when displayed.

3.2 3D Coordinate System and Display Model

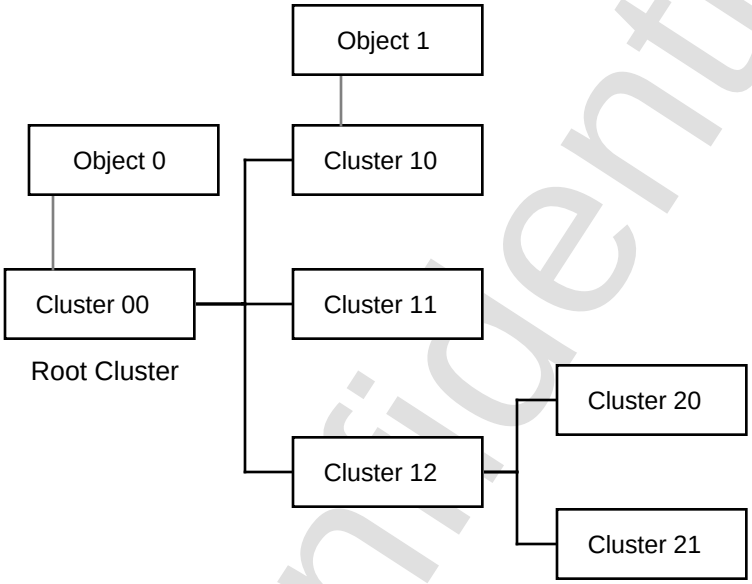
Coordinate System



Distance from the screen to the view point is fixed at 1.0.

[Display Model]

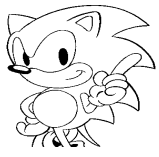
The display model is a grouping of polygons connected in a layered cluster as an object. Clusters have a mother/child-type relationship: the position of the object that is the child cluster is placed in the mother cluster body coordinate system. For this reason, when the mother cluster is moved, all of the child clusters move along with it.



3.3 Example of a Program Description

An actual example program in C language is shown below.

```
#include <machine.h>
#define _SPR3_                /* Use Sprite 3D Display Library   */
#define SPR_3USE_DOUBLE_BUF   /* Designates double buffer        */
#include “sega_spr.h”
#include “sega_scl.h”
#include “sega_int.h

SprCluster mode10;
SprCluster mode11;

#define COMMAND_MAX    1000  /* Maximum commands                */
#define GOUR_TBL_MAX   1000  /* Maximum Gouraud tables          */
#define LOOKUP_TBL_MAX 1000  /* Maximum Lookup tables           */
#define CHAR_MAX       100   /* Maximum Characters              */
#define DRAW_PRTY_MAX  256   /* Maximum Draw Priority Blocks    */
SPR_2DefineWork(work2d, COMMAND_MAX, GOUR_TBL_MAX,
                        LOOKUP_TBL_MAX, CHAR_MAX, DRAW_PRTY_MAX)
                        /* Define 2D Work Area             */
#define OBJ_SURF_MAX   16    /* Maximum Surfaces in an Object   */
#define OBJ_VERT_MAX   16    /* Max. Vertex Points in an Object */
SPR_3DefineWork(work3D, OBJ_SURF_MAX, OBJ_VERT_MAX)
                        /* Defines the 3D Work Area        */
```

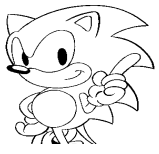


```
extern void vbStart(void);   /* V-BLANK IN Interrupt Routine    */
extern void vbEnd(void);     /* V-BLANK OUT Interrupt Routine   */

main()
 {
      set_imask(0);          /* Enable Interrupt                */

   SCL_Vdp2Init();           /* Initialize Scroll and Priority  */
   SCL_SetPriority(SCL_SP0|SCL_SP1|SCL_SP2|SCL_SP3|SCL_SP4|
                           SCL_SP5|SCL_SP6|SCL_SP7,7);
   SCL_SetSpriteMode(SCL_TYPE1,SCL_MIX,SCL_SP_WINDOW);

   SPR_2Initial(&work2d);    /*Initialize 2D Sprite Display     */

   SPR_3Initial(&work3D);    /*Initialize 3D Sprite Display     */

   INT_ChgMsk(INT_MSK_NULL, INT_MSK_VBL_IN | INT_MSK_VBL_OUT);
                           /* Disable V-BLANK Interrupt        */
   INT_SetFunc(INT_SCU_VBLK_IN, &vbStart);
                        /* Register V-BLANK IN Interrupt Routine*/
   INT_SetFunc(INT_SCU_VBLK_OUT, &vbEnd);
                        /* Register V-BLANK OUT Interrupt Routine*/
   INT_ChgMsk(INT_MSK_VBL_IN | INT_MSK_VBL_OUT, INT_MSK_NULL);
                           /* Enable V-BLANK Interrupt         */

   SPR_2FrameChgIntr(0xffff); /* Set the Frame Change Interval  */
                           /* to Undefined                     */

   SPR_3SetTexture(texture); /* Set the 3D Texture Data         */

   for(;;) {
              ______       /* Set Scroll Data                  */

      SPR_3SetLight(...);   /* Set the 3D light Source          */
      SPR_3SetView(...);    /* Set the 3D view Point            */
      SPR_2OpenCommand(SPR_2DRAW_PRTY_ON);
                           /* Open Sprite Command Write        */
      SPR_2SysClip(SPR_2MOST_FAR,&xy);
                           /* System Clip Area Command         */
      SPR_2LocalCoord(SPR_2MOST_FAR+1,&xy);
                           /* Local Coordinates Command        */
      SPR_3moveCluster(mode10,...);/* Move Root Cluster of 3D model 0*/
      SPR_3DrawMode1(mode10,...); /* Register 3D Model 0        */

      SPR_3moveCluster(mode11,...);/* Move Root Cluster of 3D model 1*/
      SPR_3DrawMode1(mode11,...); /* Register 3D Model 1        */
                        .
                        .
                        .
      SPR_3Flush();        /* Set the 3D Sprite Command        */
      SPR_2CloseCommand() ; /* Close sprite command Write      */
      SCL_DisplayFrame() ;  /* Hold Interrupt V_BLANK          */
                           /* Display Sprite and Move Scroll   */
   }
}
```

- V Blank Process Routine (The main above is a separate source file) -

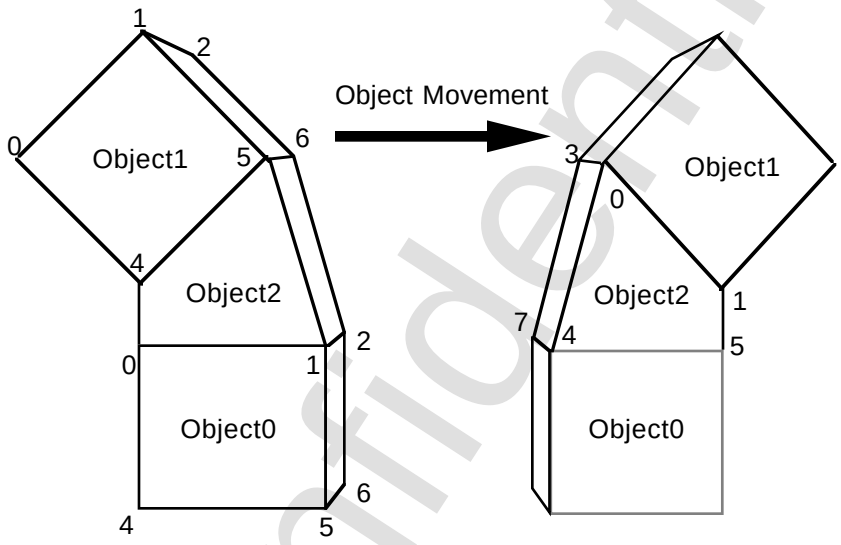
```
#include <machine.h>
#include “sega_spr.h”
#include “sega_scl.h

#pragma interrupt (VbStart)
#pragma interrupt (VbEnd)

void VbStart(void)
 {
   SCL_VblankStart();   /* V Blank start VDP Interrupt Process       */
      ———               /* Other VBlank Start Processes              */
 }

void VbEnd(void)
 {
   SCL_VblankEnd();     /* VBlank End VDP Interrupt Process          */
      ———               /* Other VBlank End Processes                */
 }
```

Polygon Z sort in the view coordinate system of the sprite 3D display library uses the sprite priority draw function of the VDP1 expansion library (2D library). To execute Z sort, priority draw in the SPR_2OpenCommand() routine must be set to on (SPR_2DRWA_PRTY_ON).

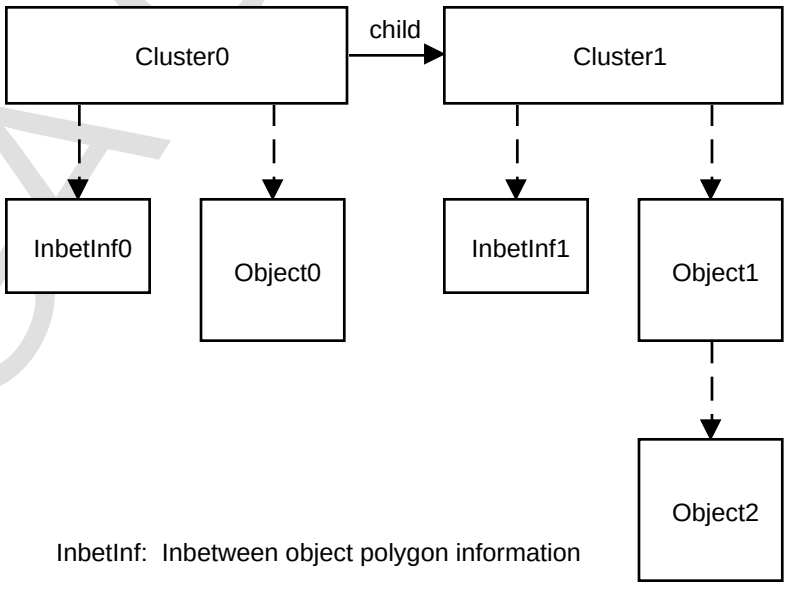


3.4 Polygon Objects That Connect Between Objects

When Object2 needs to be changed to accomodate the movement of Object1, as shown in the figure below, define the polygon between Object0 and Object1 (Object2) as an inbetween-object polygon and the shape changes are automatically drawn.



The different tables that contain the cluster, object and inbetween-object polygon information are connected as shown below.



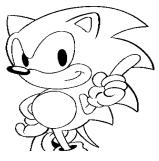
- Processing the Inbetween-object Polygon Object

1) Objects are drawn in order from the parent cluster to the child cluster; if there is more than one object in a cluster, they are drawn in the order they were connected. In the previous example, objects would be drawn in order of Object0, Object1, Object2.

2) If there is inbetween-object polygon information connected to the cluster, the inbetween-object polygon object vector data table is set using the corresponding vector data converted from the focal point coordinate system in the set table. If there is Gouraud shading, the calculated vector brightness is set into the inbetween-object polygon normal vector line data table. In the previous example, InbetInf0 sets the focal coordinate system vector data (0, 1, 2, 3) to Object2 vector data (4, 5, 6, 7); InbetInf1 sets the focal coordinate system vector data (4, 5, 6, 7) to Object2 vector data (0, 1, 2, 3).

3) If the draw object is an inbetween-object polygon, the normal vector for each surface is found after conversion to the focal coordinate system, and the object is drawn according to the draw mode. In the previous example, Object2 is the inbetween-object polygon object.

4) Conditions for setting the inbetween-object polygon.
   · If set as one of a cluster, connect it last in the object chain.
   · The normal vector calculation correction value in the object table is set as a negative value.



4.0 VDP1 Basic Processing Reference

4.1 Data Specifications

Title	Data	Data Name	No
Data Specification	Status Return Area Pointer	SPR_SpStatus	

```
typedef struct SprSpStatus  {
   Uint16  frameChgMode;     /* Frame Change Mode     *1        */
   Uint16  frameEraseMode;   /* Frame Erase Mode      *2        */
   Uint16  vbInterval;       /* V-BLANK Intervals               */
   Uint16  eraseData;        /* Frame Buffer Erase Data         */
   Uint16  eraseLeftX;       /* Frame Buffer Erase Left Side    */
   Uint16  eraseTopY;        /* Frame Buffer Erase Top          */
   Uint16  eraseRightX;      /* Frame Buffer Erase Right Side   */
   Uint16  eraseBotY;        /* Frame Buffer Erase Bottom       */
} SprSpStatus;
```

*1 Frame change Mode

```
#define AUTO_FRAME_CHG      0 /* Auto Change                    */
#define MANUAL_FRAME_CHG    1 /* Manual Change at Fixed Interval    */
#define NO_INTERVAL_FRAME_CHG   2 /* Manual Change at Undefined Interval */
#define NO_INTER_VBE_FRAME_CHG  3 /* Undefined by Vblank erase      */
                                  /* Interval Manual Change         */
```

*2 Frame Erase Mode

```
#define OFF                 0 /* Frame Erase OFF                */
#define ON                  1 /* Frame Erase ON                 */
```

4.2 List of Functions

Function	Function Name	Number
Initialize the VDP1 basic process library	**SPR_Initial**	1
Set TV Mode	**SPR_SetTvMode**	2
Get the Current Sprite Control Information	**SPR_GetStatus**	3
Set the Frame Buffer Erase Area, Erase data	**SPR_SetEraseData**	4
Check the Frame Buffer Draw End	**SPR_WaitDrawEnd**	5
Set the Sprite Draw Source Coordinate Select Mode	**SPR_SetEosMode**	6
System Register Write Macro	**SPR_WRITE_REG**	7
System Register Read Macro	**SPR_READ_REG**	8

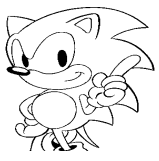
4.3 Function Specifications

Title	Function	Function Name	No
Function Specification	Initialize the VDP1 basic process library	SPR_Initial	1

Format `void SPR_Initial(Uint8 **vram)`
Input vram :VRAM address return area pointer
Output None
Function Value None
Function Sets the following values as default
- Erase Data = 0x8000 (Black)
- Erase Area = (0, 0) - (319,223)
- TV mode is normal, resolution is 320 X 224

Title	Function	Function Name	No
Function Specification	TV Mode Set	SPR_SetTvMode	2

Format `void Spr_SetTvMode(Uint16 mode, Uint16 screenSize, Uint16 doubleInterlace)`
Input mode : The following TV mode definition values can be set.
SPR_TV_NORMAL = Normal Mode
SPR_TV_HIREZ0 = Hi Resolution Mode
SPR_TV_R0T16 = Rotate 16 Mode
SPR_TV_R0T8 = Rotate 8 Mode
SPR_TV_HDTV = HDTV Mode
screenSize : Sets the screen size that corresponds to the TV mode from the definition values shown below. See the VDP1 manual for detailed configurations.
SPR_TV_320X224 = 320 x 224
SPR_TV_320X240 = 320 x 240
SPR_TV_352X224 = 352 x 224
SPR_TV_352X240 = 352 x 240
SPR_TV_640X224 = 640 x 224
SPR_TV_640X240 = 640 x 240
SPR_TV_704X224 = 704 x 224
SPR_TV_704X240 = 704 x 240
doubleInterlace : Sets the double interlace mode.
ON = Use the double interlace mode.
OFF = Do not use the double interlace mode.
Output None
Function Value None
Function Sets the TV Mode.



Title	Function	Function Name	No
Function Specification	Get the Current Sprite Control Information	SPR_GetStatus	3

Format: void SPR_GetStatus(SprSpStatus *spStatus)
Input: None
Output: SprSpStatus: Status return area pointer
Function Value: None
Function: Gets the sprite control information.

Title	Function	Function Name	No
Function Specification	Set the Frame Buffer Erase Area, Erase data	SPR_SetEraseData	4

Format: void SPR_SetEraseData(Uint16 eraseData, Uint16 leftX, Uint16 topY, Uint16 rightX, Uint16 botY)
Input: eraseData: RGB erase data
leftX : Left erase X coordinates
topY : Top erase Y coordinates
rightX : Right erase X coordinates
botY : Bottom erase Y coordinates
Output: None
Function Value: None
Function: Used to set what color and what area is erased in the erase process.

Title	Function	Function Name	No
Function Specification	Check the Frame Buffer Draw End	SPR_WaitDrawEnd	5

Format: void SPR_WaitDrawEnd(void)
Input: None
Output: None
Function Value: None
Function: Waits for the VDP1 to finish drawing to the frame buffer. This routine is called from the V-BLANK VDP interrupt process routine.

Title	Function	Function Name	No
Function Specification	Set the Sprite Draw Source Coordinate Select Mode	**SPR_SetEosMode**	6

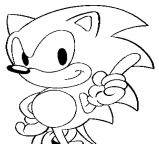
Format `void SPR_SetEosMode(Sint32 eosFlag)`
Input eosFlag : 0= Sampling of even coordinates (default)
1= Sampling of odd coordinates
Output None
Function Value None
Function Sets the source picture texture sampling coordinate mode with the sprite command draw mode when high speed draw is set.

Title	Function	Function Name	No
Function Specification	System Register Write Macro	SPR_WRITE_REG	7

Format `SPR_WRITE_REG(Uint16 reg, Uint16 val)`
Input reg : Sets the system register type from the definitions listed below.
SPR_W_TVMR = Select TV Mode
SPR_W_FBCR = Frame Buffer Change Mode
SPR_W_PTMR = Plot Trigger
SPR_W_EWDR = Erase Write Data
SPR_W_EWLR = Erase Write Upper Left Coordinate
SPR_W_EWRR = Erase Write Lower Right Coordinate
SPR_W_EWDR = End Draw
Value: Write value
Output None
Function Value None
Function Writes to the VDP1 dedicated write system register.

Title	Function	Function Name	No
Function Specification	System Register Read Macro	SPR_READ_REG	8

Format `Uint16 val = SPR_READ_REG(Uint16 reg)`
Input reg : Sets the system register type from the definitions listed below.
SPR_R_EDSR = Transfer End State
SPR_R_LOPR = Process Interrupt Table Address
SPR_R_COPR = Current Process Table Address
SPR_R_MODR = Mode Status
Output None
Function Value val : Read Value
Function Reads the register value from the VDP1 dedicated read system register.



5.0 VDP1 Expanded Processing Reference

5.1 Data Specifications

Title	Data	Data Name	No
Data Specification	Coordinate Indicator Data Type	XyInt	

Defined in sega_def.h

```
typedef struct XyInt  {
    Sint16  x;
    Sint16  y;
}  XyInt;
```

Title	Data	Data Name	No
Data Specification	Gouraud Shading Table	SprGourTbl	

```
typedef struct SprGourTbl  {
    Uint16  entry[4];
}  SprGourTbl;
```

Title	Data	Data Name	No
Data Specification	Lookup Table Data Type	SprLookupTbl	

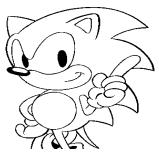
```
typedef struct SprLookupTbl {
    Uint16  entry[16];
}  SprLookupTbl;
```

Title	Data	Data Name	No
Data Specification	VRAM for Sprite Command Relative Address Data Type	SprVaddr	

```
typedef Uint16  SprVaddr;
```

Title	Data	Data Name	No
Data Specification	Sprite Command Data Types	SprSp Cmd	

```
typedef struct SprSpCmd         {/* Sprite Command Table     */
    Uint16 control;             /* control word             */
    Uint16 link;                /* command link             */
    Uint16 drowMode;            /* drow mode                */
    Uint16 color;               /* color info.              */
    Uint16 charAddr;            /* character address        */
    Uint16 charSize;            /* character size           */
    Sint16 ax;                  /* point A x                */
    Sint16 ay;                  /* point A y                */
    Sint16 bx;                  /* point B x                */
    Sint16 by;                  /* point B y                */
    Sint16 cx;                  /* point C x                */
    Sint16 cy;                  /* point C y                */
    Sint16 dx;                  /* point D x                */
    Sint16 dy;                  /* point D y                */
    Uint16 grshAddr;            /* goouraud shading table address*/
    Uint16 dummy;               /* dummy area               */
 } SprSpCmd;
```

5.2 List of Functions

Function	Function Name	Number
VDP1 Expansion Processing Work Area Definition Macro	**SPR_2DefineWork**	1
Initializing Process for the VDP1 Expansion Processing Library	**SPR_2Initlial**	2
Set the TV Mode	**SPR_2SetTvMode**	3
Set Frame Change V-Blank Interval Count	**SPR_2FrameChgIntr**	4
Set Frame Buffer Erase Data	**SPR_2FrameEraseData**	5
Set the Gouraud Shading Table	**SPR_2SetGourTbl**	6
Set the Lookup Table	**SPR_2SetLookupTbl**	7
Set Characters	**SPR_2SetChar**	8
Clear Character Area	**SPR_2ClrChar**	9
Clear All Character Area	**SPR_2ClrAllChar**	10
Convert Gouraud Shading Table Number to VRAM Address	**SPR_2GourToVRAM**	11
Convert Lookup Table Number to VRAM Address	**SPR_2LookupTblNoToVRAM**	12
Convert Character Number to VRAM Address	**SPR_2CharNoToVRAM**	13
Open Command Write Processing	**SPR_2OpenCommand**	14
Close Command Write Processing	**SPR_2CloseCommand**	15
Set Local Coordinates	**SPR_2LocalCoord**	16
Set the System Clipping Area	**SPR_2SysClip**	17
Set the User Clipping Area	**SPR_2UserClip**	18
Draw Line	**SPR_2Line**	19
Draw Polyline	**SPR_2PolyLine**	20
Draw Polygon	**SPR_2PolyGon**	21
Draw Normal Sprite	**SPR_2NormSpr**	22
Draw Scaled Sprite	**SPR_2ScaleSpr**	23
Draw Distorted Sprite	**SPR_2DistSpr**	24
Set Command	**SPR_2Cmd**	25
Flush the Command Draw Priority Chain	**SPR_2FlushDrawPrty**	26
Allocate VRAM Block area (static)	**SPR_2AllocBlock**	27
Free VRAM Block Area (static)	**SPR_2FreeBlock**	28

5.3 Function Specifications

Title	Function	Function Name	No
Function Specification	VDP1 Expansion Processing Work Area Definition Macro	SPR_2DefineWork	1

Format SPR_2DefineWork(WORK2D, COMMAND_MAX, GOUR_TBL_MAX, LOOKUP_TBL_MAX, CHAR_MAX, DRAW_PRTY_MAX)

Input
- WORK2D : Work Area Name
- COMMAND_MAX : Maximum Commands
- GOUR_TBL_MAX : Maximum Gouraud Shading Tables
- LOOKUP_TBL_MAX : Maximum Lookup Tables
- CHAR_MAX : Maximum Characters (> 0)
- DRAW_PRTY_MAX : Maximum Draw Priority Blocks (>0)

Output None

Function Value None

Function Defines the work area used by VDP1 expanded processing in the AP data area. When DRAW_PRTY_MAX=1, command draw priority is not added.

Title	Function	Function Name	No
Function Specification	Initializing Process for the VDP1 Expansion Processing Library	SPR_2Initial	2

Format void SPR_2Initial(Spr2WorkArea *workArea)

Input workArea : Work Area Definition Table

Output None

Function Value None

Function Calls up the initializing routine from the VDP1 basic processing library and, after initializing the display environment, initializes the work area for this library.

Title	Function	Function Name	No
Function Specification	Set the TV Mode	SPR_2SetTvMode	3

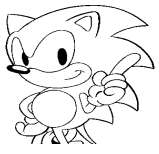
Format void Spr_2SetTvMode(Uint16 mode, Uint16 screenSize, Uint16 doubleInterlace)

Input
- mode : Sets the definition value for the TV mode.
- screenSize : Sets the definition value for the screen resolution that matches the TV mode.
- doubleInterlace : Sets the double interlace mode.

Output None

Function Value None

Function Same as the VDP1 basic processing library TV mode set routine.



Title	Function	Function Name	No
Function Specification	Set Frame Change V-Blank Interval Count	SPR_2FrameChgIntr	4

Format `void SPR_2FrameChgIntr(Uint16 interval)`
Input interval : V-BLANK interval count
Output None
Function Value None
Function Set the frame change V-BLANK interval count.
The interval values have different meanings as shown below.
0 = Sets the frame change mode to auto change mode and the intervals to 1. Cannot be sychornized with SCL_DisplayFrame ().
1 = Sets the frame change mode to auto change mode and the intervals to 1. Can be sychornized with SCL_DisplayFrame ().
0xffff = Does polygon draw frame erase-write in the undefined interval manual change mode.
0xfffe = The V-BLANK undefined interval manual change mode. The user polygon erase-write function is be used for areas not erased. Changes the frame without confirming VDP1 draw end.
Other = Fixed interval manual change mode defined by setting the interval count.
b14=0: Does erase-write
=1: Does not do erase-write.
Calls up the SCL_SetFrameInterval () routine.

Title	Function	Function Name	No
Function Specification	Set Frame Buffer Erase Data	SPR_2FrameEraseData	5

Format `void SPR_2FrameEraseData(Uint16 rgbColor)`
Input rgbColor : Erase data (RGB color)
Output None
Function Value None
Function Sets the color to be painted over the erased area in the erase processing.

Title	Function	Function Name	No
Function Specification	Set the Gouraud Shading Table	SPR_2SetGourTbl	6

Format `void SPR_2SetGourTbl(Uint16 gourTblNo, SprGourTbl *gourTbl);`
Input gourTblNo : Gouraud shading table number
gourTbl : Gouraud shading table
Output None
Function Value None
Function Copies the contents of the designated Gouraud shading table to the Gouraud shading table area in VRAM.

Title	Function	Function Name	No
Function Specification	Set the Lookup Table	SPR_2SetLookupTbl	7

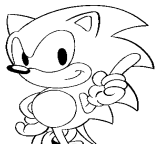
Format: void SPR_2SetlookupTbl(Uint16 LookupTblNo, SprLookupTbl *lookupTbl)
Input: LookupTblNo : Lookup table number
LookupTbl : Lookup table
Output: None
Function Value: None
Function: Copies the contents of the designated lookup table to the lookup table area in VRAM.

Title	Function	Function Name	No
Function Specification	Set Characters	SPR_2SetChar	8

Format: void SPR_2SetChar(Uint16 charNo, Uint16 colorMode, Unit16 color, Unt16 width, Uhit16 height, Unt8 *char Image)
Input: charNo : Character Number
colorMode : Color Mode (b5~b3: Same in draw mode word)
color : Color data
When color mode = 1, lookup table number.
When color mode = 0, 2, 3, 4, color bank code.
When color mode = 5, it is ignored.
width : X size
height : Y size
charImage : Character data pointer
When = 0, only aquires the character area,
Output: None
Function Value: None
Function: When the designated charNo is not assigned, or if it is assigned and the area acquired is too small for the character size, this function calculates the number of blocks required for the characters and acquires that number of blocks from the block pool and copies the character data. If overwrite is possible, the character data will be written to the same area.

Title	Function	Function Name	No
Function Specification	Clear Character Area	SPR_2ClrChar	9

Format: void SPR_2ClrChar(Uint16 charNo)
Input: charNo : Character Number
Output: None
Function Value: None
Function: Clears the VRAM block used by the character of the designated character number.



Title	Function	Function Name	No
Function Specification	Clear All Character Area	SPR_2ClrAllChar	10

Format `void SPR_2ClrAllChar(void)`
Input None
Output None
Function Value None
Function Clears the entire character area.

Title	Function	Function Name	No
Function Specification	Convert Gouraud Shading Table Number to VRAM Address	SPR_2GourTblNoToVRAM	11

Format `SprVaddr addr = SPR_2GourTblNoToVram(Uint16 gourTblNo)`
Input gourTblNo : GouraudShading Table Number
Output None
Function Value addr : VRAM internal relative address/8
Function Converts the Gouraudshading table number to VRAM address.

Title	Function	Function Name	No
Function Specification	Convert Lookup Table Number to VRAM Address	SPR_2LookupTblNoToVRAM	12

Format `SprVaddr addr = SPR_2LookupTblNoToVram(Uint16 LookupTblNo)`
Input LookupTblNo : Lookup Table Number
Output None
Function Value addr : VRAM internal relative address/8
Function Converts the lookup table number to VRAM address.

Title	Function	Function Name	No
Function Specification	Convert Character Number to VRAM Address	SPR_2CharNoToVRAM	13

Format `SprVaddr addr = SPR_2CharNoToVram(Uint16 charNo)`
Input charNo : Character Number
Output None
Function Value addr : VRAM internal relative address/8
Function Converts the character number to VRAM address.

Title	Function	Function Name	No
Function Specification	Open Command Write Processing	SPR_2OpenCommand	14

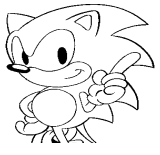
Format `void SPR_2OpenCommand(Uint16 drawPrtyFlag)`
Input drawPrtyFlag : Command draw priority enable/disable flag.
SPR_2DRAW_PRTY_ON = Enable command draw priority
SPR_2DRAW_PRTY_OFF = Disable command draw priority
Output None
Function Value None
Function Sets the sprite command write start position to the start of the VRAM command area. This routine must be called before calling any of the following routines.
SPR_2LocalCoord() SPR_2SysClip() SPR_2UserClip() SPR_2line()
SPR_2polyLine() SPR_2Polygon() SPR_2NormSpr() SPR_2ScaleSpr
SPR_2DistSpr() SPR_2Cmd()

Title	Function	Function Name	No
Function Specification	Close Command Write Processing	SPR_2CloseCommand	15

Format `void SPR_2CloseCommand(void)`
Input None
Output None
Function Value None
Function Chains the commands contained in VRAM according to the priority number when command draw priority is enabled. It writes the end sprite command and toggles the VRAM area reference switch.

Title	Function	Function Name	No
Function Specification	Set Local Coordinates	SPR_2LocalCoord	16

Format `void SPR_2LocalCoord(Sint32 drawPrty, XyInt *xy)`
Input drawPrty : Command draw priority number
xy : Local coordinate relative coordinate
Output None
Function Value None
Function Sets the local coordinates.



Title	Function	Function Name	No
Function Specification	Set the System Clipping Area	SPR_2SysClip	17

Format `void SPR_2SysClip(Sint32 drawPrty, XyInt *xy)`
Input drawPrty : Command draw priority number
xy : Lower right coordinates
Output None
Function Value None
Function Set the system clipping area.

Title	Function	Function Name	No
Function Specification	Set the User Clipping Area	SPR_2UserClip	18

Format `void SPR_2UserClip(Sint32 drawPrty, XyInt xy[2])`
Input drawPrty : Command draw priority number
xy [0] : Upper left coordinates
xy [1] : Lower right coordinates
Output None
Function Value None
Function Set the user clipping area.

Title	Function	Function Name	No
Function Specification	Draw Line	SPR_2Line	19

Format `void SPR_2Line(Sint32 drawPrty, Uint16 drowMode, Uint16 color, XyInt xy[2], Uint16 gourTblNo)`
Input drawPrty : Command draw priority number
drowMode : Draw Mode(Same in draw mode word)
color : Color mode or lookup table number
xy[2] : 2 points of the line
gourTblNo : GouraudShading Table Number
NO_GOUR(=0xffff) = No Gouraud shading table designation
Output None
Function Value None
Function Draws a line.

Title	Function	Function Name	No
Function Specification	Draw Polyline	SPR_2PolyLine	20

Format: void SPR_2PolyLine(Sint32 drawPrty, Uint16 drowMode, Uint16 color, XyInt xy[4], Uint16 gourTblNo)

Input:
- drawPrty : Command draw priority number
- drowMode : Draw Mode(Same in draw mode word)
- color : Color mode or lookup table number
- xy[4] : 4 points of the polyline
- gourTblNo : GouraudShading Table Number
  NO_GOUR(=0xffff) = No Gouraudshading table designation

Output: None

Function Value: None

Function: Draws a polyline.

Title	Function	Function Name	No
Function Specification	Draw Polygon	SPR_2PolyGon	21

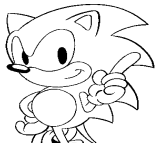
Format: void SPR_2Polygon(Sint32 drawPrty, Uint16 drowMode, Uint16 color, XyInt xy[4], Uint16 gourTblNo)

Input:
- drawPrty : Command draw priority number
- drowMode : Draw Mode(Same in draw mode word)
- color : Color mode or lookup table number
- xy[4] : 4 points of the polygon
- gourTblNo : GouraudShading Table Number
  NO_GOUR(=0xffff) = No Gouraudshading table designation

Output: None

Function Value: None

Function: Draws a polygon.



Title	Function	Function Name	No
Function Specification	Draw Normal Sprite	SPR_2NormSpr	22

Format: void SPR_2NormSpr(Sint32 drawPrty, Uint16 dir, Uint16 drowMode, Uint16 color, Uint16 charNo, XyInt *xy, Uint16 gourTblNo)

Input:
- drawPrty : Command draw priority number
- dir : Character reverse instructions (b11~b8: same in control word)
- drowMode : Draw Mode(Same in draw mode word)
- color : Color code or lookup table number When 0xffff, The color data set using SPR_2SetChar () is set.
- chrNo : Character Number
- xy : Upper left Coordinates
- gourTblNo : GouraudShading Table Number NO_GOUR(=0xffff) = No Gouraudshading table designation

Output: None

Function Value: None

Function: Draws a normal sprite.

Title	Function	Function Name	No
Function Specification	Draw Scaled Sprite	SPR_2ScaleSpr	23

Format: void SPR_2ScalSpr(Sint32 drawPrty, Uint16 zoomDir, Uint16 drowMode, Uint16 color, Uint16 charNo, XyInt xy[2], Uint16 gourTblNo)

Input:
- drawPrty : Command draw priority number
- zoomDir : Zoom and character reverse instructions (b11~b8, b5, b4: same in control word)
- drowMode : Draw Mode(Same in draw mode word)
- color : Color code or lookup table number When 0xffff, The color data set using SPR_2SetChar () is set.
- charNo : Character Number
- xy [2] : 2 point vertex, or fixed point coordinate/ display width
- gourTblNo : GouraudShading Table Number NO_GOUR(=0xffff) = No Gouraud shading table designation

Output: None

Function Value: None

Function: Draws a scaled sprite.

Title	Function	Function Name	No
Function Specification	Draw Distorted Sprite	SPR_2DistSpr	24

Format: void SPR_2DistSpr(Sint32 drawPrty, Uint16 dir, Uint16 drowMode, Uint16 color, Uint16 charNo, XyInt xy[4], Uint16 gourTblNo)

Input:
- drawPrty : Command draw priority number
- dir : Character reverse instructions (b11~b8: same in control word)
- drowMode : Draw Mode(Same in draw mode word)
- color : Color code or lookup table number When 0xffff, The color data set using SPR_2SetChar () is set.
- charNo : Character Number
- xy[4] : 4 vertex points
- gourTblNo : GouraudShading Table Number NO_GOUR(=0xffff) = No Gouraud shading table designation

Output: None

Function Value: None

Function: Draws a distorted sprite.

Title	Function	Function Name	No
Function Specification	Set Command	SPR_2Cmd	25

Format: void SPR_2Cmd(Sint32 drawPrty, SprSpCmd *spCmd)

Input:
- drawPrty : Command draw priority number
- spCmd : 32 byte sprite command.

Output: None

Function Value: None

Function: Sets the designated sprite command in the user command area as is.

Title	Function	Function Name	No
Function Specification	Flush the Command Draw Priority Chain	SPR_2FlushDrawPrty	26

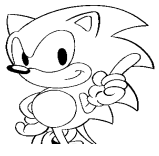
Format: void SPR_2FlashDrawPrty(void)

Input: None

Output: None

Function Value: None

Function: Chains the commands contained in VRAM according to the priority number when command draw priority is enabled and clears the draw priority control area.



Title	Function	Function Name	No
Function Specification	Allocate VRAM Block area (static)	SPR_2AllocBlock	27

Format SprVaddr addr =SPR_2AllocBlock(Uint16 size)
Input size : Block size (32 bytes is 1 unit)
Output None
Function Value addr : Returns VRAM relative address /8 of the acquired block area positions.
Function Acquires from the VRAM block pool the designated size block. This routine cannot be freed externally, but the specification was included in the event that functions were added to this library.

Title	Function	Function Name	No
Function Specification	Free VRAM Block Area (static)	SPR_2FreeBlock	28

Format void SPR_2FreeBlock(SPRVaddr addr, Uint16 size)
Input addr : Returns the freed block area in VRAM relative address/8.
size : Block size (32 bytes is 1 unit)
Output None
Function Value None
Function Frees the designated block area from the VRAM block pool. This routine cannot be freed externally, but the specification was included in the event that functions were added to this library.

6.0 VDP1 3D Reference

6.1 Data Specifications

Title	Data	Data Name	No
Data Specification	Cluster Definition	SprCluster	

```
typedef struct SprCluster  {
   Uint16         no;        /* Cluster Number                          */
   Uint16         angleSeq;  /* Rotation order                          */
   MthXyz         angle;     /* Rotate on parent cluster coord. system */
   MthXyz         point;     /* Base coord. parent cluster coor. sys.*/
   SprObject3D    *object    /* 3D Object                               */
   SprCluster     *next;     /* Next cluster                            */
   SprCluster     *child;    /* child cluster                           */
   SprInbetInf    *inbetInf;/*  Inbetween object polygon infor. */
   void           (*transStart) (SprCluster*);
                             /* Before coord. coversion start, user    */
                             /* callbak routine */
   void        (transEnd) (SprCluster*, SprObject3D*, MthMatrix, MthXyz*);
                             /* Before coord. coversion end, user      */
                             /* callbak routine */
   void           *context;  /* User context area                       */
} SprCluster;
```

"no" is used by the user callback routine to identify the cluster table, it can be set as desired.

```
angleSeq = ROT_SEQ_ZYX : Rotate object in Z→Y→X order.
         = ROT_SEQ_ZXY :      "          Z→X→Y   "
         = ROT_SEQ_YZX :      "          Y→Z→X   "
         = ROT_SEQ_YXZ :      "          Y→X→Z   "
         = ROT_SEQ_XYZ :      "          X→Y→Z   "
         = ROT_SEQ_XZY :      "          X→Z→Y   "
```

If a 3D object, the next cluster or a child cluster will not connect, each of the object, the next cluster, and the child are set to 0.

inbetInf is 0 if there is no inbetween-object polyon information.

transStart indicates the user call back routine that is called before coordinate conversion begins. In the routine, items such as cluster movement and object data changes, take place. This is 0 if there is no call back routine.

[transStart routine calling sequence]

void transStart(SprCluster *cluster);
cluster : Auto cluster table

transEnd indicates the user call back routine that is called after the coordinate conversion begins. This call back routine is called up for each 3D object connected to the object. This is 0 if there is no call back routine.

[transStart routine calling sequence]

```
void  transEnd(SprCluster *cluster, SprObject3D *object,
                        MthMatrix *worldMatrix, MthXyz *worldVertPoint);
    cluster        : Auto cluster table
    object         : 3D object table
    worldMatrix    : Conversion matrix (3 column, 4 row) to word coord. system
    worldVertPoint : vertex coordinate value table in the world coordinate system.
                     (Returns when #define SPR_3NEED_WORLD_VERT is
                     defined with the 3D sprite work area definition macro.)
```

Context indicates the context area that is used for each cluster by the user call back routine.

```
typedef struct SprObject3D  {
   Uint16       no;         /* Object Number                          */
   Uint16       dispFlag;   /* Display Flag                           */
   Uint16       vertCount;  /* Vertex count                           */
   Uint16       surfaceCount; /* Surface count                        */
   MthXyz       *vertPoint; /* Vertex coordinate table                */
   MthXyz       *vertNormal;/* Vertex line vector table               */
   SprSurface   *surface    /* Surface definition table               */
   MthXyz       *surfaceNormal;/* Surface  vector table               */
   MthXyz       *surfacceVert;/* Surface coord. table                 */
   Uint16       **shdIdxTbl;/* Shading Index Table                    */
   Fixed32      surfNormK;/*Correction calc. for surface normal vector */
   SprObject3D  *next;      /* Next 3D Object                         */
} SprObject3D;
```

"no" is used by the user call back routine to identify the cluster table; it can be set as desired.

```
dispFlag b15,b14 = 00:  Display Polygon
                 = 10:  Display Polyline
            b12  =  1:  Double surface polygon
         b9,b8   = 00:  No Shading
                   01:  Flat Shading
                   10:  Gouraud Shading
            b4   =  1:  Inbetween-object polygon object
```

vertNormal : Set when using Gouraud shading.

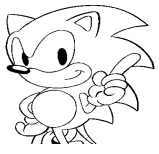
surface : Pointer to the table that defines the vertexes and color information that make up each surface.

surfaceNormal : Pointer to the table that defines the line for each surface.

surfaceVert : Sets the coordinate table pointer of a representative point (center point) on the surface used to calculate brightness.

shdIdxTbl : Sets the shading table index table when using the shading table to do flat shading. If this parameter is set while setting Gouraud shading, the shdIdxTbl [0] becomes the Gouraud shading gray code table. If this parameter is set in flat shading while surface definition draw mode is set to texture, the shdIdxTbl [0] becomes the flat shading gray code table.

surfNormK : Set when surface normal vector calculation using the SPR_SetNormVect () routine is used, or when this object is an inbetween-object polygon object. For details, see the mathmatical calculation library MTH_ComputeNormVect () routine, surfNorm parameter. When an inbetween-object polygon object is utilized, a negative value must be used.



If the normal vector table, shading index table, or next object is not connected, each of vertNormal, shdInxTbl, and next is set to 0.

The shading table is set at 32 tones in the RGB code format.

```
Uint16 shadingTbl[32];  0← dark   bright → 31
```

If the line vector ta If surface polygon designation is 1, half of polygon data indicates both surfaces.

Title	Data	Data Name	No
Data Specification	Surface Definition	SprSurface	

```
typedef struct SprSurface {
   Uint16       vertNo[4];  /* Vertex number to configure the surface */
   Uint16       drawMode;   /* Draw Mode                              */
   Uint16       color;      /* Color Data                             */
} SprSurface;

drawMode b15,b14 = 00:  color is color code
                   01:  color is the texture character number
                   10:  color is the shading table index number
                   11:  color is the auto shading base RGB code

         b13,b12 = 00:  After a coordinate change, the lowest value of the
                        4 coordinates is used for z Sort No Shading
                   01:  After a coordinate change, the highest value of
                        the 4 coordinates is used for z Sort No Shading
                   10:  After a coordinate change, the middle value of the
                        4 coordinates is used for z Sort No Shading

          b11-b0:       Same as the sprite draw mode word.
```

If the texture was set using the drawMode, the color bit changes as follows. color b15,b14 indicate texture reverse mode.

```
         b15,b14 = 00:  No Reversal
                   01:  Reverse left-right
                   10:  Reverse Up-down
                   11:  Reverse left-right, up-down

         b13-b0     :   Luxture character number
```

Title	Data	Data Name	No
Data Specification	Inbetween-object polygon object information	SprInbetInf	

```
typedef struct SprInbetInfo {
   Sint32       vertCount;  /* Number of vertexes called          */
   SprObject3D  *fromObj;   /* Connecting vertex data object      */
   Uint16       *fromVertNo;/*Called vertex number distribution*/
   SprObject3D  *toObj;   /* Connecting vertex data set object  */
   Uint16       *toVertNo;  /* Set vertex number distribution     */
   SprInbetInf  *next;  /* Next inbetween-object polygon info. */
} SprTexture;
```

If there is no inbetween-object polygon object information, next is set to 0.

Title	Data	Data Name	No
Data Specification	Texture Table	SprTexture	

```
typedef struct SprTexture {
   Uint16       charNo;     /* Character number*/
   Uint16       ColorMode;  /* Color Mode                        */
   Uint16       Color;      /* Color data                        */
   Uint16       width;      /* Character width                   */
   Uint16       height;     /* Character height                  */
   Uint8        *charData;  /* Character data pointer            */
   SprLookupTbl *lookupTbl; /* Lookup table pointer              */
} SprTexture;
```

SprTexture texture[n]; The charNo of the last entry is set to 0xffff (stopper).

colorMode : b5-b3 are the same as sprite draw mode word.

color : Color data
When color mode = 1, lookup table number.
When color mode = 0, 2, 3, 4, color bank code.
When color mode = 5, it is ignored.

Title	Data	Data Name	No
Data Specification	3D Status Data Table	Spr3DStatus	

```
typedef struct Spr3dStatus {
   MthXyz   lightAngle;     /* Light source angle               */
   MthXyz   viewCoordPoint; /* View Coord. sys. focal point     */
   MthXyz   viewPoint;      /* View coordinate                  */
   MthXyz   viewAngle;      /* View angle                       */
   Sint32   viewAngleSeq;   /* View angle rotate sequence       */
   Sint32   zSortMode;      /* Z sort Z coord. value use mode   */
   Fixed32  zSortZMin;      /* Min value of Z sort view coord.  */
   Fixed32  zSortZMax;      /* Max value of Z sort view coord.  */
   Fixed32  clipZMin;       /* Min Z value of view coord. clip  */
   Fixed32  clipZMax;       /* Max Z value of view coord. clip  */
   Sint32   clipLevel;      /* Clipping Level                   */
   MthXyz   unitPixel;      /* Screen pixels for x, y1.0        */
} Spr3dStatus;
```


6.2 List of Functions

Function	Function Name	Number
3D Sprite Work Area Definition Macro	**SPR_3DefineWork**	1
Initialize 3D Sprite Display	**SPR_3Initial**	2
Set Clipping Mode	**SPR_3SetClipLevel**	3
Set Unit Pixel Count	**SPR_3SetPixelCount**	4
Set Light	**SPR_3SetLight**	5
Set View	**SPR_3SetView**	6
Move Cluster	**SPR_3MoveCluster**	7
Record Model	**SPR_3DrawModel**	8
Draw Model	**SPR_3Flush**	9
Set Texture	**SPR_3SetTexture**	10
Clear Texture Area	**SPR_3ClrTexture**	11
Function call for all clusters	**SPR_3CallAllCluster**	12
Change texture color data	**SPR_3ChangeTexColor**	13
Set Z sort minimum and maximum	**SPR_3SetZSortMinMax**	14
Get current 3D status data	**SPR_3GetStatus**	15
Set object normal surface vector	**SPR_3SetSurfNormVect**	16
VDP1 high speed draw parameter set	**SPR_3SetDrawSpeed**	17

6.3 Function Specifications

Title	Function	Function Name	No
Function Specification	VDP1 3D Work Area Definition Macro	SPR_3DefineWork	1

Format
```
[#define SPR_3USE_DOUBLE_BUF]
[#define SPR_3NEED_WORLD_VERT]
#include "sega_spr.h"
    SPR_3DefineWork(WORK3D, OBJ_SURF_MAX, OBJ_VERT_MAX)
```

Input
WORK3D : Name of work area
OBJ_SURF_MAX : Maximum surfaces of an object
OBJ_VERT_MAX : Maximum vertexes of an object

Function
Defines the work area used by VDP1 3D display in the AP data area.
The #define SPR_3USE_DOUBLE_BUF can be skipped by using two of the designated object vertex coordinates or the surface brightness tables, and running the DSP coordinate conversion and SH processing in parallel to increase speed.
The #define SPR_3NEED_WORLD_VERT can be skipped by notifying the vertex coordinate table in the world coordinate system when the coordinate conversion results are notified.
#define SPR_3USE_DOUBLE_BUF and #define SPR_3NEED_WORD_VERTH must be defined before defining #define "sega_spr.h".

Title	Function	Function Name	No
Function Specification	Initialize 3D VDP1	SPR_3Initial	2

Format `void SPR_3Initial(Spr3WorkArea *workArea)`
Input workArea : Work area definition table
Output None
Function Value None
Function Initializes the VDP1 3D display.

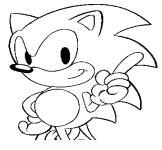
- The view point is the world coordinate system base point, the focal angle is (0,0,0) (Z positive direction), and rotation is set in order of X →Y→ Z.
- The light source direction is (0,0,0) (Z positive direction).
- The clipping level is 2, the Z coordinate are from -0.005 to the minimum negative value display range max/min values of the view coordinate system.

Title	Function	Function Name	No
Function Specification	Set Clipping Mode	SPR_3SetClipLevel	3

Format `void SPR_SetClipLevel(Uint16 clipLevel, Fixed32 clipZmin, Fixed32 clipZmax)`
Input clipLevel : Clipping level number
0=No clipping
1=Clip at view coord. system Z range (After coord. conversion)
2=Delete polygons that are not on screen. (After transparent conversion)
3=Clip the frame buffer boundary (After transparent conversion)
clipZmin : View coordinate system, Z coordinate min. clip value
clipZmax : View coordinate system, Z coordinate max. clip value
Output None
Function Value None
Function Sets the polygon clipping level. The upper level includes the functions of the lower level. Clipping can be done in level 1, with the polygon max Z coordinate value in the view coordinate system, but that range has to be set in clipZmin and clipZmax before executing SPR3_DrawMode().

Title	Function	Function Name	No
Function Specification	Set Unit Pixel Count	SPR_3SetPexelCount	4

Format `void SPR_3SetPixelCount (Uint16 pixelCountX, Uint16 pixelCountY)`
Input pixelCountX : Screen X unit pixel count
pixelCountY : Screen Y unit pixel count
Output None
Function Value None
Function Sets the screen pixel count for converting the screen to transparent XY at 1.0 each. Each is set at 256 when initialized.



Title	Function	Function Name	No
Function Specification	Set Light	SPR_3SetLight	5

Format: void SPR_3SetLight (Uint16 moveKind, MthXyz *lightAngle)

Input:
- moveKind : Type of move amount
  - b0: 0= Relative Move, 1= Absolute move
  - b1: 0= Rotate move amount is angle, 1= Rotate move amount is unit vector
- lightAngle : If the light source rotation amount is an angle, the designated range of the move is calculated according to the equation below. Vector designations are converted to angles.
  FIXED(-180.0)≤ Rotate amount≤FIXED(180.0)
  Rotate operation is done in X→Y→Z order.

Output: None

Function Value: None

Function: Sets the light angle.

Title	Function	Function Name	No
Function Specification	Set View	SPR_3SetView	6

Format: void SPR_3SetView(Uint16 moveKind, MthXyz *pivotViewPoint, MthXyz *viewPoint, MthXyz *viewAngle, Uint16 angleSeq)

Input:
- moveKind : Type of move amount
  - b0: 0= Relative Move, 1= Absolute move
  - b1: 0= Rotate move amount is angle, 1= Rotate move amount is unit vector
- viewPoint : Position of viewpoint or amount of horizontal move.
  Ignored when it is 0 at the rotation position of viewpoint within the world coordinate system.
- viewAngle : If the viewpoint rotation amount is an angle, the designated range of the move is calculated according to the equation below. Vector designations are converted to angles.
  FIXED(-180.0)≤ Rotate amount≤FIXED(180.0)
- angleSeq : Viewpoint rotation operation
- viewCoordPoint: horizontal movement or view point in the view coordinate system.
  Ignored when 0.
  Initial value is (0, 0, 0).

Output: None

Function Value: None

Function Viewpoint is moved within the world coordinate system; that position is center for rotation. If there is a viewCoordPoint designation, the viewpoint is moved to the designated position from the start point using the view point coordinate system.

```
angleSeq = ROT_SEQ_ZYX : Rotate object in Z→Y→X order.
         = ROT_SEQ_ZXY :      "           Z→X→Y   "
         = ROT_SEQ_YZX :      "           Y→Z→X   "
         = ROT_SEQ_YXZ :      "           Y→X→Z   "
         = ROT_SEQ_XYZ :      "           X→Y→Z   "
         = ROT_SEQ_XZY :      "           X→Z→Y   "
```

Title	Function	Function Name	No
Function Specification	Move Cluster	SPR_3MoveCluster	7

Format `void SPR_3MoveCluster(SprCluster *cluster, Uint16 moveKind, MthXyz *angle,MthXyz *point)`

Input
- cluster : Pointer to the cluster table to be moved
- moveKind : Type of move amount
  - b0: 0= Relative Move
    1= Absolute move
  - b1: 0= Rotate move amount is angle
    1= Rotate move amount is unit vector
- angle : If the amount is an angle, the designated range of the move is calculated according to the equation below. Vector designations are converted to angles.
  FIXED(-180.0)≤ Rotate amount≤FIXED(180.0)
- point : Amount of horizontal movement

Output None

Function Value None

Function Rotates the cluster move, executes in the order of the horizontal move. When either angle or point are 0, they are ignored.

Title	Function	Function Name	No
Function Specification	Record Model	SPR_3DrawModel	8

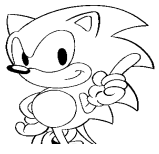
Format `void SPR_3DrawModel (SprCluster *rootCluster)`

Input rootCluster : Pointer to the root cluster table of the model to be displayed.

Output None

Function Value None

Function Records the model.



Title	Function	Function Name	No
Function Specification	Draw Model	SPR_3Flush	9

Format void SPR_3Flush (void)
Input None
Output None
Function Value None
Function Draws the model.
Completes Z sort of the polygon group's viewpoint coordinate system registered by the SPR_3DrawMode ().

Title	Function	Function Name	No
Function Specification	Set Texture	SPR_3SetTexture	10

Format void SPR_3SetTexture(SprTexture *texture)
Input texture : Texture table pointer
Output None
Function Value None
Function Sets the texture.

Title	Function	Function Name	No
Function Specification	Clear Texture Area	SPR_3ClrTexture	11

Format void SPR_3ClrTexture(SprTexture *texture)
Input texture : Texture table pointer
Output None
Function Value None
Function Clears the texture.

Title	Function	Function Name	No
Function Specification	Function call for all clusters	SPR_3CallAllCluster	12

Format void SPR_3CallAllCluster(SprCluster *cluster
void (*userFunc) (SprCluster*))
Input cluster : Root cluster table pointer
userFunc: User function
Output None
Function Value None
Function Calls the indicated function using the class table from each cluster connected to the root cluster as parameters.

Title	Function	Function Name	No
Function Specification	Change texture color data	SPR_3ChangeTexColor	13

Format `void SPR_3ChangeTexColor (Uint16 charNo, Uint16 color, SprLookupTbl *lookupTbl)`

Input
char No : Character number
color : Color data
lookup table number or color bank code
lookupTbl: Lookup table pointer

Output None

Function Value None

Function Changes the texture color data and color lookup table indicated by the registered character number. If lookupTbl is 0, only the color is changed, the color lookup table is not registered.

Title	Function	Function Name	No
Function Specification	Set Z sort min.imum and maximum	SPR_3SetZSortMinMax	14

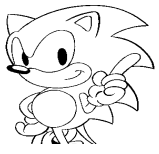
Format `void SPR_3SetZSortMinMax1 (Uint16 zSortMode, Fixed32 zSortMin, Fixed32 zSortMax)`

Input
zSortMode: Use Z sort Z coordinate value mode
ZSORT_FLOAT_MODE=Float mode
ZSORT_FIXED_MODE= Fized mode
zSortMin: Min value of view coordinate Z sort Z coordinate
zSortMax: Max value of view coordinate Z sort Z coordinate

Output None

Function Value None

Function
zSortMin and zSortMax are parameters used to set the Z range used to allocate the draw number blocks and is set before the SPR3DrawMode () routine is executed.
If the Z coordinate value mode is set to the float mode, then zSortMin and zSortMax are used as initial values. After that, the maximum and minimum Z coordinate values of the view coordinate system from the last draw is used for the Z range.
In the fixed mode, the designated zSortMin and zSortMax values are used.
When initial values are set during the SPR_3Initial () routine, zSortMin is set at -10.0 and zSortMax at 0.0; the Z coordinate value mode is set to floating. The view coordinate system heads in the minus direction when the view coordinate value is 0.0. The block used for Z sort is the VDP1 expanded process draw priority block. To make Z sort faster, the priority blocks in the 2D work area definition must be set to maximum.
Also, when doing Z sort, the drawPrtyFlag in the SPR_2OpenCommand () routine must be set to SPR_2DRAW_PRTY_ON.



Title	Function	Function Name	No
Function Specification	Get current 3D status data	SPR_3GetStatus	15

Format: void SPR_3GetStatus(Spr3dStatus *spr3dStatus)
Input: None
Output: spr3dStatus : 3D status data table pointer
Function Value: None
Function: Gets the current 3D status data.

Title	Function	Function Name	No
Function Specification	Set object normal surface vector	SPR_3SetSurfNormVect	16

Format: void SPR_3SetSurfNormVect (SprObject3D *obj)
Input: None
Output: obj : 3D object
Function Value: None
Function: Calculates the normal vector from the designated 3D object surface vertex and sets the normal surface vector table. The surface vertex order of the normal vector is clockwise and vertical. The 3D object surfNormK parameter must be set.

Title	Function	Function Name	No
Function Specification	VDP1 high speed draw parameter set	SPR_3SetDrawSpeed	17

Format: void SPR_3SetDrawSpeed (Sint32 hssFlag, Sint32 eosFlag, Sint32 pclpFlag)
Input:
hssFlag : High speed shrink flag
(Set in the texture polygon draw mode)
0= Precision priority draw (default)
1= Speed priority draw
eosFlag : Sampling coordinates of the source texture when speed priority is selected.
0= Even coordinate sampling (default)
1= Odd coordinate sampling
pclpFlag : Preclipping enable/disable flag
0= Enable (default)
1= Disable
Output: None
Function Value: None
Function: Sets the high speed draw mode in the VDP1 sprite command draw mode. See the VDP1 hardware manual about high speed clipping and preclipping.

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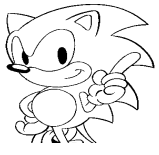


VDP2 Library

1.0 Guide

1.1 Objective

- Automates hardware-related processing such as VDP1 initialization, register operation, etc., to reduce the load on the application author.
- Using this library enables one to set the registers without really being aware of V-BLANK. Automates hardware-related processing related to V-BLANK interrupt processing to reduce the load on the application author. Also supplies the V-BLANK interrupt processing routine and frame change settings routine needed to display VDP1 and VDP2.

1.2 Explanation

VDP2 is only allowed to access a register or color RAM during V-BLANK. In addition, it cannot read many registers.

The VDP2 library contains a register buffer; normal reading and writing to registers occur in this buffer and are copied to the register during the next V-BLANK. (See the reference for more information on the register buffer.) The functions of this library are divided into larger groups as shown below.

Initializing Function

Must be executed first when starting up the VDP2 library.

Table Creation & Data Set Functions

Refer to the VDP2 user's manual or reference manual when setting each of the parameters.

Functions Relating to Screen Display Operations

Enables scroll screen movement, enlarge/reduce, and rotation.

Line Screen Setting Functions

Sets line screen and back screen data.

Window Setting Function

Executes window settings.

Functions Related to VDP1

Functions that must be set in order to display VDP1 (sprite) frame buffer contents.

Functions related to Color RAM

Used to set or change the pallet.

Functions Related to Priority

Gets information and sets priorities.

Color Calculation Functions

Processes color calculations. Used to add gradated effects and depict translucent objects or cause ghosts to appear, space ships to warp out, etc.

Color offset Functions

Processing that adds offset to color. Used for fade-in, fade-out, black-out, white-out, etc. Also effective when used to change a blue sky to a red sunset sky.

Other Special Effect Functions

Used for shade calculations, adding line color screen, and shadow bit settings. (Line color screen can only be used in color calculations.)

Register Buffer Write / Read Macro

Supplies the bit access macro for reading the register buffer of priority-related functions used by this library. There are about 90 varieties, each of read and write macros.

- Write macro command line
  SCL_SET_<BitName>(arg);
- Read macro command line
  ret = SCL_GET_,BitName>();
  <BitName> : Bit name (Refer to "VDP2 User's Manual")
  arg, ret : Refer to the "VDP2 User's Manual"

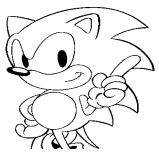
V-BLANK Interrupt Processing Functions

Explains the frame change process used to display sprite (VDP1) and scroll (VDP2) through the V-BLANK VDP interrupt routine supplied by this library.

Frame Change Process

- Auto Change Mode (Non-synchronous Mode)
  Every 1/60th of a second, the VRAM is automatically changed and erase data is written to the frame buffer and the sprite is written (frame change). For this reason, the SCL_DisplayFrame() routine does not need to be called.

- Fixed Interval Manual Change (Synchronous Mode)
  If a number greater than one is set into the SCL_SetFrameInterval, described later, then frame change is executed by the V-BLANK VDP interrupt routine one time for each interval count. However, to accomplish this, command write to VRAM must end and the SCL_DisplayFrame() routine must be called. Waiting for frame change is done within the SCL_DisplayFrame routine.



- Undefined Interval Manual Change Mode (Synchronous Mode)
  The undefined interval manual change mode starts when 0xffff is set as the V-BLANK interval count in the SCL_SetFrameInterval().

  In the undefined mode, the frame is changed simultaneously with the first V-BLANK interrupt when the VRAM command write ends and the SCL_DisplayFrame routine is called. However, before frame change, the VDP1 must have finished writing to the frame buffer or it goes into a loop to wait. Also, the frame buffer cannot be erased during frame change, so the user must use the VRAM command lead to clear the frame buffer with a polygon.

V-BLANK Interrupt Processing

When the user uses the sprite (VDP1), or scroll (VDP2) display library, INT_SetScuFunc() must be used to set the following routine that is used to create the V-BLANK interrupt routine. Also, an independent interrupt process routine can be used without calling the following routines.

- V-BLANK Start VDP Interrupt Process Routine
  If the fixed interval manual change mode is being used, the V-BLANK repetitions are counted and the frame change flag is set to on when the interval count is reached. In the undefined interval manual change mode, the flag is always on.

  Also, by writing the contents of the scroll data to the scroll register during V-BLANK with the frame change timing in this access routine, scroll motion and sprite frame change are simultaneous. If this method does not match AP, an independent interrupt routine must be used.
- V-BLANK End VDP Interrupt Process Routine
  If the frame change flag is on, frame change is executed.

1.3 Basic Library Usage

Basic VDP2 library usage is contained in "15.1 Operation Flow in Chapter 15 Using VDP2, of the VDP2 User's Manual". Follow that flow with the appropriate library.

VRAM mapping is particularly important for using this library; along with the setting of cycle patterns which have a high degree of freedom in the settings, but are also quite complex, and sample programs are explained.

VRAM Mapping

VRAM and Data Size Comparison Chart

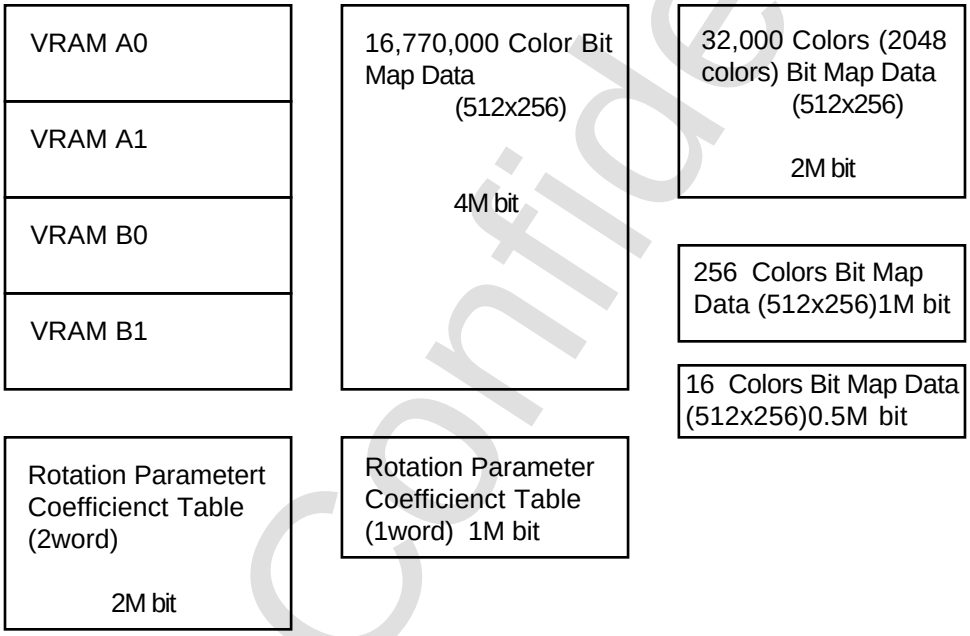
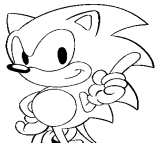


Figure 1 VRAM and DA TA Size Comparison

Effective use of VDP2 depends on how the data is placed in the VRAM.
For example, to display a 16,770,000 color bitmap image, all of the VRAM would be filled with no room to display other images.

Next, VRAM mapping examples will be explained. The image data used in the example is bitmap data. This is because the data size is fixed and can be used for direct mapping. In the cell format, the data size changes depending on how the data is stored. If there are many common parts, the memory usage is more efficient than bitmapping.



[Example 1] **Using Five Screens Displayable by the VDP2**

Other than NBG2 and NBG3, all data is bitmap. If rotating screen 1 is 256 colors and the normal 4 screens are 16 colors, it will be as follows. To move the rotating screen, a rotation parameter table is required. If X and Y axis rotation is to be done, a rotation parameter coefficient table must also be prepared.

In this library, the rotation parameter coefficient table is usually placed at the lead of each bank (VRAM A0, VRAM A1, VRAM B0, VRAM B1). However, the X and Y axis rotation can only be used in 2kWord (4kByte). This allows the remaining area (124kByte) to be filled with the rotation parameter table, line scroll table, line color table, back screen data, etc. (1M bit = 128kByte)

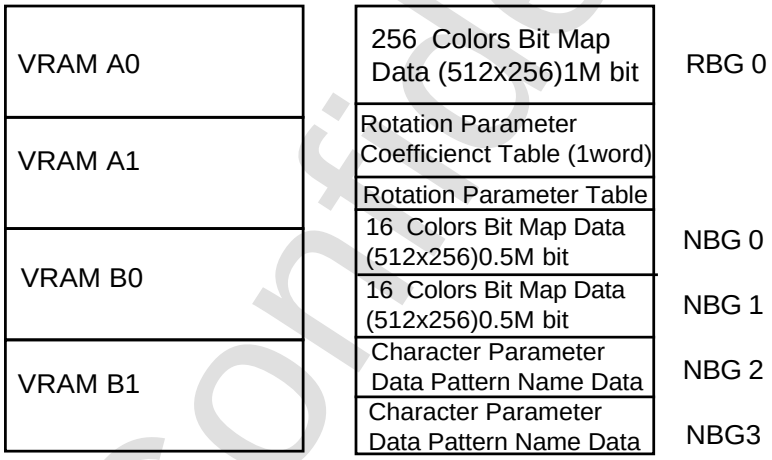


Figure 2 Using 5 Screens that can be displayed by the VDP2

[Example 2] **Using 2 Rotation Screens**

Only one type of rotation data, such as character data (bitmap data), pattern name data, rotation parameter coefficient data, etc., can be placed in each bank. Furthermore, RGB1 placement is fixed with character pattern data in VRAM B0, and pattern name data is VRAM B1.

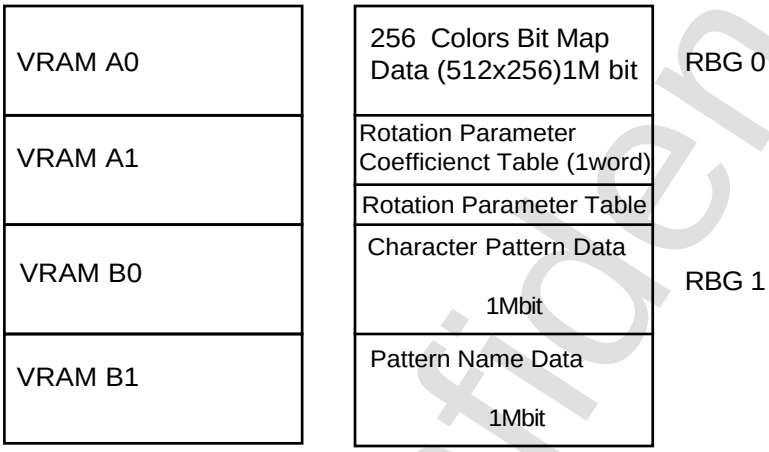
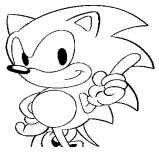


Figure 3 Using 2 Rotation Screens



Setting VRAMAssignments and Cycle Patterns

VDP2 displays by reading from VRAM at the same time as the scroll screen data is being scanned on the TV. VRAM access during display is either 4 times (hi-res display) or 8 times (normal display) being one access unit (1 cycle) with cycles being repeated.

There is a cycle pattern register prepared for each VRAM and bank, VRAM A(VRAM A0, VRAM A1) and VRAM B (VRAM B0, VRAM B1). Access is displayed as 4 bit for one command. (Refer to "3.4 VRAM Access during display in the VDP2 User's Manual").

The number of accesses set in the cycle pattern depends on the data type and use. These need to be applied to the cycle pattern table.

Table 1 Access count for the required pattern name table data for 1 cycle

Item	NBG0 ~ NBG3			RBG0, RBG1
Compression	Times 1	Times 1/2	Times 1/4	–
VRAM access needed for 1 cycle	1	2	4	8

Table 2 Data Access for character pattern data (bitmap pattern data)

Item	NBG0 ~ NBG3								RBG0, RBG1		
TV Display Mode									Normal	Hi-res	Custom
Character colors	16			256		2048	32768	16770000	–	–	–
Compression Rate	1	1/2	1/4	1	1/2	1	1	1	–	–	–
VRAM access needed for one cycle	1	2	4	2	4	4	4	8	8	4	4

For example, with 16 color bitmap data (uses character pattern data), up to four sets of 512 x 256 data can placed in just one or in either VRAM A or VRAM B. If this is applied to the normal scroll screen, the access amount would total 4 times. However, normal scroll screens NBG0 and NBG1 have compression functions. Using this function and setting the compression ratio to 1/4 would increase the access count to 10, which exceeds 8, and the screen would not be displayed correctly. In this case, if VRAM allocation is done, the access count will be distributed and the screen will display correctly.

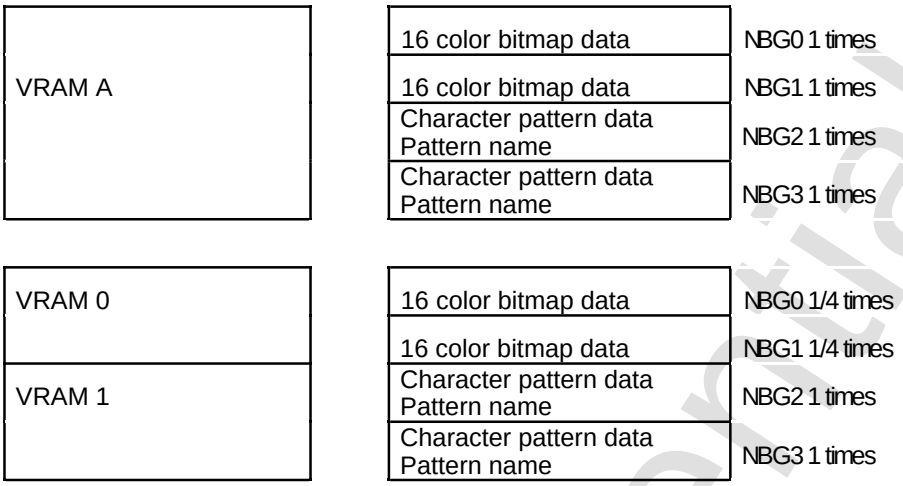
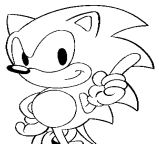


Figure 4 16 Color Bitmap Data

Program Examples

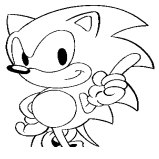
Program examples using the C language are shown below.

```
#include <machine.h>
#include "sega_scl.h"

                                /* Set the cycle pattern table            */
Uint16 n0_cycle[]={0x44ff, 0x0fff,/* VRAM A(A0)NBG0 Character pattern
                                     and pattern name table on          */
                  0xffff, 0xffff, /* VRAM A1  VRAM A is not allocated so   */
                                  /* is not used  */
                  0xffff, 0xffff, /* VRAM B(B0)  Non Table                 */
                  0xffff, 0xffff};/* VRAM B1  VRAM B is not allocated so   */
                                  /* is not used  */

extern Uint16 ColData[];          /* Pallet data pointer                   */

SclConfig   scfg;
main()
 {
   SCL_Vdp2Init();                /* Initial VDP2 library                  */

   SCL_SetDisplayMode(SCL_NON_INTER, SCL_224LINE, SCL_NOMAL_A);
                                  /* Sets the screen mode                  */
   SCL_SetColRamMode(SCL_CRM_2048):
                                  /* Sets the color RAM mode               */
   SCL_AlloColRam(SCL_NBG0, 256, ON);
                                  /* Reserve pallet area                   */
   SCL_SetColRam(SCL_NBG0, 0, 265, ColData);
                                  /* Sets the pallet data                  */
```

```
    ..................          /* Store the scroll data in VDP2 VRAM     */

    SCL_InitConfigTb(&scfg);    /* Initialize scroll NBG0 configuration   */
    scfg.dispenbl = ON;         /* Display NBG0 on the screen             */
    scfg.charsize = SCL_CHAR_SIZE_1X1;
    scfg.pnamesize = SCL_PN1WORD;
    scfg.platesize = SCL_PL_SIZE_1X1;
    scfg.coltype = SCL_COL_TYPE_256;
    scfg.flip = SCL_PN_12BIT;
    scfg.datatype = SCL_CELL;
    scfg.plate_addr[0] = SCL_VDP2_VRAM_A+0x0000;
    scfg.plate_addr[1] = SCL_VDP2_VRAM_A+0x2000;
    scfg.plate_addr[2] = SCL_VDP2_VRAM_A+0x4000;
    scfg.plate_addr[3] = SCL_VDP2_VRAM_A+0x6000;
    SCL_SetConfig(SCL_NBG0, &scfg);

    SCL_SetPriority(SCL_NBG0, 7); /* Set the priority to maximum          */

    SCL_SetCycleTable(n0_cycle);  /* Set the cycle pattern                */

    INT_SetScuFunc(.....);        /* Record the V-Blank routine           */

    set_imask(0);                 /* Enables the interrupt.+              */

    SCL_Open(SCL_NBG0);           /* NBG0 open processing                 */
    SCL_Move(FIXED(1), FIXED(1), 0);/* Types of scroll move functions     */
        .
        .
        .
    SCL_Close(SCL_NBG0);          /* End scroll processing                */

    SCL_DisplayFrame();           /* Wait for V-BLANK display scroll      */
}
```

(There is no page 54 in the original Japanese document.)



2.0 Reference

2.1 Data Specifications

Title	Data	Data Name	No
Data Specification	2D Data Structure	SclXy	

```
typedef struct SclXy  {
      Fixed32 x;
      Fixed32 y;
}  SclXy;
```

Title	Data	Data Name	No
Data Specification	3D Data Structure	SclXyz	

```
typedef struct SclXyz  {
      Fixed32 x;
      Fixed32 y;
      Fixed32 z;
}  SclXyz;
```

Title	Data	Data Name	No
Data Specification	Data Structure of the Line Parameter Table	SclLineTb	

```
typedef struct SclLineTb  {
      Fixed32 h;        /* Horizontal screen scroll value       */
      Fixed32 v;        /* Vertical screen scroll value         */
      Fixed32 dh;       /* Increment of horizontal coordinates  */
}  SclLineTb;
```

Title	Data	Data Name	No
Data Specification	Data Structure of the line window	SclLinWindowTb	

```
typedef struct SclLinWindowTb  {
      Uint16 start;     /* Horizontal start point coordinate    */
      Uint16 end;       /* Horizontal end point coordinate      */
}  SclLinWindowTb;
```

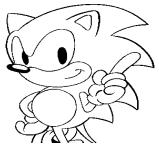
Title	Data	Data Name	No
Data Specification	Structure of the RGB Color Table Data	SclRgb	

```
typedef struct SclRgb  {
      Sint16 red;       /* Red      */
      Sint16 green;     /* Green    */
      Sint16 blue;      /* Blue     */
}  SclRgb;
```

Title	Data	Data Name	No
Data Specification	VRAM Configuration Data Structure	SclVramConfig	

```
typedef struct SclVramConfig  {
   Uint32   ktboffsetA; /* Indicates the coefficient rotation   */
                        /* parameter table in the relative VRAM */
                        /* address.  If SCL_RBG_K is indicated, */
                        /* the relative address is designated there.   */
   Uint32   ktboffsetB; /* Designated units are 2048 (0x400) byte*/
                        /* Specified in relative address        */
   Uint8    vramModeA;  /* Separate VRAM A into 2 patterns      */
                        /* ON/OFF                               */
   Uint8    vramModeB;  /* Separate VRAM B into 2 patterns      */
                        /* ON/OFF                               */
   Uint8    vramA0;     /* Use VRAM A0 for which rotation screen*/
                        /* If not separated, uses all of VRAM A */
                        /*   SCL_NON                            */
                        /*        Do not place rotation data    */
                        /*   SCL_RBG0_K                         */
                        /*        Place RBG0 coefficient data   */
                        /*   SCL_RBG0_PN                        */
                        /*        Place RGB0n pattern name data */
                        /*   SCL_RBG0_CHAR                      */
                        /*        Place RGB0 character          */
   Uint8    vramA1;     /* Use VRAMA1 for which rotation screen */
                        /* Invalid if VRAMA is not separated    */
   Uint8    vramB0;     /* Use VRAM B0 for which rotation screen*/
                        /* If not separated, uses all of VRAM B */
   Uint8    vramB1;     /* Use VRAM B1 for which rotation screen*/
                        /* Invalid if VRAM B is not separated   */
   Uint8    colram;     /* Indicates whether to place coefficient data  */
                        /*  into color RAM.  If coefficient data is     */
                        /*  placed in VRAM, it can't be used. Unless the*/
                        /*  color RAM mode is SCL_CRM15-2048, it can't  */
                        /*  be used. Specified with SCL_RBG0_K or SCL_NON*/
}  SclVramConfig;
```

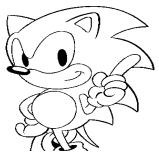
Note: If any type of rotation data is placed in a VRAM bank, other data cannot be placed there. However, if ktboffsetA or ktboffsetB is set, other data can be placed with coefficient data.



Refer to the "VDP2 User's Manual" for details on parameter settings.

```
typedef struct SclConfig  {
   Uint8      dispenbl;     /* Display ON/OFF                                  */
                            /* Screen display enable register (180020h)        */
                            /*   ON  Display picture on screen                 */
                            /*   OFF Do not display picture on screen          */
   Uint8      charsize;     /* Character size                                  */
                            /* Char. control reg.(180028h-18002ah)             */
                            /*   SCL_CHAR_SIZE_1X1              */
                            /*      Set to 1X1                  */
                            /*   SCL_CHAR_SIZE_2x2              */
                            /*      Set to 2x2                  */
   Uint8      pnamesize     /* Pattern Name Size                               */
                            /* Pattern Name Cntrl. reg.(180030h-18038h)        */
                            /*   SCL_PN2WORD                    */
                            /*      Set to 2Word units          */
                            /*   SCL_PN1WORD                    */
                            /*      Set to 1Word units          */
   Uint8      platesize;    /* Plane Size                                      */
                            /* Plane size register (18003ah)                   */
                            /*   SCL_PL_SIZE_1X1                */
                            /*      Set to 1X1                  */
                            /*   SCL_PL_SIZE_2X1                */
                            /*      Set to 2X1                  */
                            /*   SCL_PL_SIZE_2X2                */
                            /*      Set to 2X2                  */
   Uint8      bmpsize;      /* Bitmap size */
                            /* Char. control reg.(180028h-18002ah)             */
                            /*   SCL_BMP_SIZE_512X256           */
                            /*      Set to 512X256              */
                            /*   SCL_BMP_SIZE_512X512           */
                            /*      Set to 512X512              */
                            /*   SCL_BMP_SIZE_1024X256          */
                            /*      Set to 1024X256             */
                            /*   SCL_BMP_SIZE_1024X512          */
                            /*      Set to 1024X512             */
   Uint8      coltype;      /* Character Colors  */
                            /* Char. control reg.(180028h-18002ah)             */
                            /*   SCL_COL_TYPE_16                */
                            /*      Sets to 16 colors           */
                            /*   SCL_COL_TYPE_256               */
                            /*      Sets to 256 colors          */
                            /*   SCL_COL_TYPE_2048              */
                            /*      Sets to 2048 colors         */
                            /*   SCL_COL_TYPE_32K               */
                            /*      Sets to 32K colors          */
                            /*   SCL_COL_TYPE_1M                */
                            /*      Sets to 16,770,000 colors   */
   Uint8      datatype;     /*   Enable bitmap                 */
                            /* Char. control reg.(180028h-18002ah)             */
                            /*   SCL_BITMAP                                    */
                            /*      Set to bitmap format                       */
```

```
                            /*   SCL_CELL                                  */
                            /*      Sets the cell format                   */
    Uint8      mapover;     /* Over screen processing                      */
                            /* Over screen process register (18003ah)      */
                            /*  SCL_OVER0                                  */
                            /*   Repeat image that was set as display area */
                            /*   outside the display area.                 */
                            /*  SCL_OVER1                                  */
                            /*   Repeat pattern designated by the screen   */
                            /*   over pattern name register                */
                            /*   (Only rotation screen)                    */
                            /*  SCL_OVER_2                                 */
                            /*   Make areas outside of display transparent */
                            /*  SCL_OVER_3                                 */
                            /*   Make the display area 512X512 and make all*/
                            /*   other areas transparent.                  */
    Uint8      flip         /* Character number support mode               */
                            /* Designates whether to use special functions */
                            /* and reverse functions when the pattern name */
                            /* size is 1Word.  If designated, the character*/
                            /* number is 10bit, if not 12bit               */
                            /* Pattern Name Cntrl Register (180030h~180038h)*/
                            /*   SCL_PN_10BIT                              */
                            /*      Enables special and reverse functions  */
                            /*   SCL_PN_12BIT                              */
                            /*      Disables special and reverse functions */
    Uint16  patnamecontrl;  /* Aux data in the pattern name control register*/
    Uint32 plate_addr[16];  /* Scroll Screen Map Register                  */
                            /* If cell format, designates pattern name     */
                            /* table lead address                          */
                            /* If bitmap format, designates bitmap data    */
                            /* lead address                                */
                            /* Normal(180040h~18004eh)                     */
                            /* Rotate(180050h~18006eh)                     */
} Sclconfig;
```

Title	Data	Data Name	No
Data Specification	Structure of line & and vertical cell scroll parameter data	SclLineParam	

Refer to the "VDP2 User's Manual" for details on parameter settings.

```
typedef struct SclLineParam  {
   Uint8      delta_enbl;    /* Enable Line Zoom                          */
                             /* Line & Vertical cell scroll register (18009ah)*/
                             /*   ON/OFF                                  */
   Uint8      v_enbl;        /* Enable line scroll (perpendicular)        */
                             /* Line & Vertical cell scroll register (18009ah)*/
                             /*   ON/OFF                                  */
   Uint8      h_enbl         /* Enable line scroll (horizontal)           */
                             /* Line & Vertical cell scroll register (18009ah)*/
                             /*   ON/OFF                                  */
   Uint8      cell_enbl;     /* Enable vertical cell scroll               */
                             /* Line & Vertical cell scroll register (18009ah)*/
                             /*   ON/OFF                                  */
   Uint8      interval;      /* Line scroll interval                      */
                             /* Line & Vertical cell scroll register (18009ah)*/
                             /*   SCL_1_LINE                              */
                             /*     Sets the line scroll data table every 1 */
                             /*     line.                                 */
                             /*   SCL_2_LINE                              */
                             /*     Sets the line scroll data table every 2 */
                             /*     lines.                                */
                             /*   SCL_4_LINE                              */
                             /*     Sets the line scroll data table every 4 */
                             /*     lines.                                */
   Uint32     line_addr;     /* Line scroll address register(18009ch~18009eh)*/
                             /* Sets the VRAM address for line scroll table  */
   Uint32     cell_addr;     /* Vert. cell scroll table address register (18009c~18009e)*/
                             /* Sets VRAM address for cell scroll table      */
   GlbLineTb  line_tbl[];    /* Line scroll table                         */
   Fixed32    cell_tbl[];    /* Vertical cell scroll address register     */
} SclLineParam;
```

Title	Data	Data Name	No
Data Specification	VDP2 Register Buffer 1	SclSysReg	

```
typedef struct SclSysReg  {
                        /* Address contents                      */
   Uint16  tvmode;      /* 18000H TV screen mode                 */
   Unit16  extenbl;     /* 18002H External signal                */
   Unit16  tvstatus;    /* 18004H Screen status                  */
   Unit16  vramsize;    /* 18006H VRAM size                      */
   Unit16  H_val;       /* 18008H H counter                      */
   Unit16  V_val;       /* 1800AH V counter                      */
   Unit16  vramchg;     /* 1800CH                                */
   Unit16  ramcontrl;   /* 1800EH RAM control                    */
   Unit16  vramcyc[8];  /* 18010H VRAM cycle pattern             */
   Unit16  dispenbl;    /* 18020H Enable screen display          */
   Unit16  mosaic;      /* 18022H Mosaic control                 */
   Unit16  specialcode_sel;/* 18024H Select special code         */
   Unit16  specialcode;  /* 18026H Special function control      */
} SclSysReg;
```

Symbols are recorded in this library as shown below. After this symbol is written, and the global variable "SclProcess" has a 1 written to it, then that will be reflected in the register during the next V-BLANK.

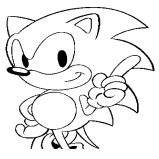
```
SclSysReg   Scl_s_reg;
```

Title	Data	Data Name	No
Data Specification	VDP2 Register Buffer 2	SclDataset	

```
typedef struct SclDataset  {
                        /* Address contents                          */
   Uint16  charcontrl0;  /* 18028H Charater control (NBG0, NBG1)    */
   Unit16  charcontrl1;  /* 1802AH Character control (NBG2, NBG3, RBG0) */
   Unit16  bmpalnum0;    /* 1802CH Bitmap pallet number (NBG0, NBG1)  */
   Unit16  bmpalnum1;    /* 1802EH Bitmap pallet number (RBG0)  */
   Unit16  patnamecontrl[15]/* 18030H Pattern name control          */
   Unit16  platesize;    /* 1803AH Plane size                     */
   Unit16  mapoffset0;   /* 1803CH Map offset (NBG0~NBG3)         */
   Unit16  mapoffset1;   /* 1803EH Map offset (rotate parameter A, B)  */
   Unit16  normap[8];    /* 18040H Map (normal scroll)            */
   Unit16  rotmap[16];   /* 18050H Map (rotate parameter A, B)  */
   } SclDataset;
```

Symbols are recorded in this library as shown below. After this symbol is written, and the global variable "SclProcess" has a 1 written to it, then that will be reflected in the register during the next V-BLANK.

```
SclDataset  Scl_d_reg;
```

Title	Data	Data Name	No
Data Specification	VDP2 Register Buffer 3	SclNorscl	

```
typedef struct SclNorscl  {
                        /* Address contents                          */
   Fixed32 n0_move_x;   /* 18070H H screen scroll value (NBG0)       */
   Fixed32 n0_move_y;   /* 18074H V screen scroll value (NBG0)       */
   Fixed32 n0_delta_x;  /* 18078H H coordinate increase (NBG0)       */
   Fixed32 n0_delta_y;  /* 1807CH V coordinate increase (NBG0)       */
   Fixed32 n1_move_x;   /* 18080H H screen scroll value (NBG1)       */
   Fixed32 n1_move_y;   /* 18084H V screen scroll value (NBG1)       */
   Fixed32 n1_delta_x;  /* 18088H H coordinate increase (NBG1)       */
   Fixed32 n1_delta_y;  /* 1808CH V coordinate increase (NBG1)       */
   Uint16  n2_move_x;   /* 18090H H screen scroll value (NBG2)       */
   Unit16  n2_move_y;   /* 18092H V screen scroll value (NBG2)       */
   Unit16  n3_move_x;   /* 18094H H screen scroll value (NBG3)       */
   Unit16  n3_move_y;   /* 18096H V screen scroll value (NBG3)       */
   Unit16  zoomenbl;    /* 18098H Enable compression                 */
   Unit16  linecontrl;  /* 1809AH line & V cell cntrl (NBG0, NBG1)   */
   Unit16  celladdr;    /* 1809CH V cell scroll tbl addr (NBG0, NBG1) */
   Unit16  lineaddr[2]; /* 180A0H Line control table address         */
   Unit16  linecolmode; /* 180A8H Line color screen table address*/
   Unit16  backcolmode; /* 180ACH Back screen table address          */
} SclNorscl;
```

Symbols are recorded in this library as shown below. After this symbol is written, and the global variable "SclProcess" has a 1 written to it, then that will be reflected in the register during the next V-BLANK.

```
SclNorscl   Scl_n_reg;
```

Title	Data	Data Name	No
Data Specification	VDP2 Register Buffer 4	SclRotscl	

```
typedef struct SclRotsel  {
                        /* Address contents                          */
   Uint16  paramode;    /* 1800B0H Rotate parameter mode             */
   Unit16  paramcontrl; /* 1800B2H Rotate parameter list control*/
   Unit16  k_contrl;    /* 1800B4H Coefficient table control         */
   Unit16  k_offset;    /* 1800B6H Coefficient table address offset  */
   Unit16  mapover[2]   /* 1800B8H Screen over pattern name          */
   Unit16  paramaddr;   /* 1800BAH Rotate parameter table address*/
   } SclRotsel;
```

Symbols are recorded in this library as shown below. After this symbol is written, and the global variable "SclProcess" has a 1 written to it, then that will be reflected in the register during the next V-BLANK.

```
SclRotscl       Scl_r_reg;
```

Title	Data	Data Name	No
Data Specification	VDP2 Register Buffer 5	SclWinscl	

```
typedef struct SclWinscl  {
                            /* Address contents                          */
   Uint16  win0_start[2];   /* 1800C0H Window position (w0, start XY) */
   Unit16  win0_end[2];     /* 1800C4H Window position (w0, end XY)   */
   Unit16  win0_start[2];   /* 1800C8H Window position (w0, start XY) */
   Unit16  win0_end[2];     /* 1800CCH Window position (w0, end XY)   */
   Unit16  wincontrl940;    /* 1800D0H Window control  */
   Unit16  linewin0_addr;   /* 1800D8H Line Window table address (W0)*/
   Unit16  linewin1_addr;   /* 1800DCH Line Window table address (W0)*/
} SclWinscl;
```

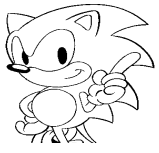
Symbols are recorded in this library as shown below. After this symbol is written, and the global variable "SclProcess" has a 1 written to it, then that will be reflected in the register during the next V-BLANK.

```
SclWinscl   Scl_w_reg;
```

Title	Data	Data Name	No
Data Specification	XY Size of screens used in the library	SdDisplayX, SclDisplayY	

This is a 2Byte global variable. When this variable is referenced, the display vertical and horizontal size changes. By using the library and setting the display mode, this can automatically be reflected.

```
Uint16      SclDisplayX;
Uint16      SclDisplayY;
```

2.2 List of Functions

Function	Function Name	Number
[Initializing Functions]		
Initialize Library	SCL_Vdp2Init	1
[Table Creation and Data Set Functions]		
Set display mode	SCL_SetDisplay Mode	2
Initialize VRAM configuration data table	SCL_InitVramConfigTb	3
Initialize scroll configuration data table	SCL_InitConfigTb	4
Set the VDP2 VRAM usage method	SCL_SetVramConfig	5
Set the scroll configuration	SCL_SetConfig	6
Set cycle patterns	SCL_SetCycleTable	7
[Functions Related to the Display Screen Functions]		
Scroll open process	SCL_Open	8
Scroll close process	SCL_Close	9
Initialize line and vertical cell scroll parameter table	SCL_InitLineParamTb	10
Set line and vertical cell scroll parameters	SCL_SetLineParam	11
Move scroll (Amount of move : absolute coord.)	SCL_MoveTo	12
Move scroll (Amount of move : relative coord.)	SCL_Move	13
Enlarge or reduce scroll	SCL_Scale	14
Initialize the rotation parameter table	SCL_InitRotateTable	15
Set rotation view	SCL_SetRotateViewPoint	16
Set the display rotate center coordinates	SCL_SetRotateCenterDisp	17
Set rotation center	SCL_SetRotateCenter	18
Scroll rotate (angle : absolute coord.)	SCL_RotateTo	19
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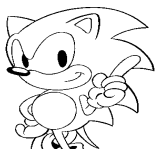
Set scale coefficient data in the rotate coefficient table	SCL_SetCoefficientData	21
Set mosaic process	SCL_SetMosaic	22
[Line Screen Setting Functions]		
Set line color screen data	SCL_SetLncl	23
Set back screen data	SCL_SetBack	24
[Window Setting Functions]		
Set normal rectangle window	SCL_SetWindow	25
Set normal line window	SCL_SetLineWindow	26
Set sprite window	SCL_SetSpriteWindow	27

Function	Function Name	Number
[Functions Related to VDP1]		
Set different sprite modes	SCL_SetSpriteMode	28
[Functions Related to Color RAM]		
Set color RAM mode	SCL_SetColRamMode	29
Get color RAM mode	SCL_GetColRamMode	30
Set color RAM color data	SCL_SetColRamCol	31
Allocate area for color RAM	SCL_AllocColRam	32
Free area allocated for color RAM	SCL_FreeColRam	33
Set auto color change	SCL_SetAutoColChg	34
Get the color RAM address offset	SCL_GetColRamOffset	35
[Functions Related to Priority]		
Set priorities	SCL_SetPriority	36
Get priorities	SCL_GetPriority	37
[Functions Related to Color Calculations]		
Set color calculation conditions (SPRITE)	SCL_SetColMixMode	38
Set color calculation mix	SCL_SetColMixRate	39
Set auto color calculation	SCL_SetAutoColMix	40
[Functions Related to Color Offset]		
Set color offset	SCL_SetColOffset	41
Increase and decrease the color offset value	SCL_IncColOffset	42
Set the auto color offset	SCL_SetAutoColOffset	43
[Other Special Effect Functions]		
Enable blur calculations	SCL_EnableBlur	44
Disable blur calculations	SCL-DisableBlur	45
Enable line color screen	SCL_EnableLineCol	46
Disable line color screen	SCL_DisableLineCol	47
Set shadow bit	SCL_SetShadowBit	48
[Functions Related to V-BLANK Interrupt Processing]		
Set frame change interval count	SCL_SetFrameInterval	49
Wait for frame change request to end	SCL_DisplayFrame	50
V-BLANK start VDP interrupt processing	SCL_VblankStart	51
V-BLANK end VDP interrupt processing	SCL_VblankEnd	52
[Abort Function]		
Force abort of automatic VE	SCL_AborAutoVe	53



2.3 Function Specifications

Title	Function	Function Name	No
Function Specification	Initialize library	SCL_Vdp2Init	1

Format: void SCL_Vdp2Init(void)
Input: None
Output: None
Function Value: None
Function: Initializes the library. This command must be executed once before using the library.

Title	Function	Function Name	No
Function Specification	Set display mode	SCL_SetDisplayMode	2

Format: void SCL_SetDisplayMode(Uint8 interlace, Uint8 vertical, Uint8 horizontal)
Input:
interlace : Interlace mode setting
- SCL_NON_INTER : Noninterlace
- SCL_SINGLE_INTER : Single interlace
- SCL_DOUBLE_INTER : Double interlace

vertical : Vertical resolution bit
- SCL_224LINE : 224 lines
- SCL_240LINE : 240 lines
- SCL_256LINE : 256 lines

horizontal : Horizontal resolution bit
- SCL_NORMAL_A : 320 Pixels : Normal Graphic A
- SCL_NORMAL_B : 352 Pixels : Normal Graphic B
- SCL_HIRESO_A : 640 Pixels : Hi-res Normal Graphic A
- SCL_HIRESO_B :704 Pixels : Hi-res Normal Graphic B
- SCL_NORMAL_AE : 320 Pixels : Custom Normal Graphic A
- SCL_NORMAL_BE : 352 Pixels : Custom Normal Graphic B
- SCL_HIRESO_AE : 640 Pixels : Custom Hi-res Graphic A
- SCL_HIRESO_BE : 704 Pixels : Custom HIi-res Graphic B

Output: None
Function Value: None
Function: Sets the display mode.
Comments: When changing the horizontal resolution from A to B, SH2 clock changes from 76 to 78. (Example: SCL_NORMAL)A → SCL_NORMAL_B) Be careful because VDP1 and VDP2 settings are reset at this time.

Title	Function	Function Name	No
Function Specification	Initialize VRAM configuration table	SCL_InitVramConfigTb	3

Format void SCL_InitVramConfigTb(SclVramConfig *tp)
Input tp : VRAM configuration table
Output None
Function Value None
Function Writes the default values to the VRAM configuration table.

Title	Function	Function Name	No
Function Specification	Initialize scroll configuration data table	SCL_InitConfigTb	4

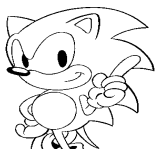
Format void SCL_InitConfigTb(SclConfig *scfg)
Input scfg : Scroll configuration data
Output None
Function Value None
Function Initializes the scroll configuration data table.

Title	Function	Function Name	No
Function Specification	Set the VDP2 VRAM usage method	SCL_SetVramConfig	5

Format void SCL_SetVramConfig(SclVramConfig *tp)
Input tp : VRAM configuration table.
Output None
Function Value None
Function Sets the VDP2 VRAM usage method.
Example Allocates VRAM B; each bank is identified for RBG0 character and pattern name data.

```
sample()
   {
      SclVramConfig tp;

      SCL_InitVramConfigTb(&tp);
      tp.vramModeB = ON          /* Allocates VRAM B for use                */
      tp.vramB0 = SCL_RBG0_CHAR; /* Places RBG0 character data              */
      tp.vramB1 = SCL_RBG0_PN;   /* Places RBG0 pattern name data           */
      SCL_SetVramConfig(&tp);
   }
```

Title	Function	Function Name	No
Function Specification	Set the scroll configuration	SCL_SetConfig	6

Format: void SCL_SetConfig(Uint16 sclnum, SclConfig *scfg)
Input: sclnum : scroll screen number
Select one of six screens SCL_NBG0, SCL_NBG1, SCL_NBG2, SCL_NBG3, SCL_RBG0, SCL_RBG1
scfg : Scroll configuration table pointer
Output: None
Function Value: None
Function: Sets the scroll configuration.
Comments: When setting rotation screen data, the SCL_IntRotateTable() must be run first.

Title	Function	Function Name	No
Function Specification	Set VRAM cycle pattern table	SCL_SetCycleTable	7

Format: void SCL_SetCycleTable(Uint16 *tp)
Input: tp : Cycle pattern table
Output: None
Function Value: None
Function: Sets the cycle pattern table.
Comments: If the cycle pattern table is not set correctly, the normal scroll screen will not display properly. It is advised to have an understanding of Chapter 3 RAM, "3.4 VRAM Access Methods During Display Intervals" in the VDP2 User's Manual.
Example 1: Image : NBG0 256 colors (with 1/2 scale display)
VRAM A: Places the NBG0 character pattern data.
VRAM B : Places the NBG0 pattern name table.

```
Uint16 cycle[] = {        /* Cycle pattern table        */
       0x4444, 0xffff,    /* VRAM A(A0)                 */
       0xffff, 0xffff,    /* VRAM A1 Not used           */
       0x00ff, 0xffff,    /* VRAM B(B0)                 */
       0xffff, 0xffff,    /* VRAM B1 Not used           */
}
sample()
{
       SCL_SetCycleTable(&cycle);
}
```

Example 2 Image : NBG0 16.77 million colors bitmap data
VRAM A: Places the NBG0 bitmap data.
VRAM B : Places the NBG0 bitmap data.

```
Uint16 cycle[] = {        /* Cycle pattern table       */
       0x4444, 0x4444,    /* VRAM A(A0)                */
       0xffff, 0xffff,    /* VRAM A1 Not used          */
       0x4444, 0x4444,    /* VRAM B(B0)                */
       0xffff, 0xffff,    /* VRAM B1 Not used          */
}
sample()
{
       SCL_SetCycleTable(&cycle);
}
```

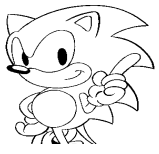
Example 3 Image : RBG0 256 color bitmap data
NBG0 16 colors bitmap data (1/4 reduced)
NBG1 16 colors bitmap data (1/2 reduced)
NBG2 16 colors character data / pattern name data
NBG3 16 colors character data / pattern name data
VRAM A0 : Places the RBG0 bitmap data.
VRAM A1 : Places the rotate parameter coefficient table.
Places the rotate parameter table.
VRAM B0 : Places the NBG0 bitmap data.
Places the NBG1 bitmap data.
VRAM B1 : Places NBG2 character and pattern name data
Places NBG3 character and pattern name data

```
Uint16 cycle[] = {        /* Cycle pattern table     */
       0xffff, 0xffff,    /* VRAM A0                 */
       0xffff, 0xffff,    /* VRAM A1                 */
       0x4444, 0xff55,    /* VRAM B0                 */
       0x23ff, 0x67ff,    /* VRAM B1                 */
}

sample()
{
       SCLVramConfig   tp;

       SCL_InitVramConfigTb(&tp);
       tb.vramModeA = ON           /* Allocate and use VRAM A       */
       tp.vramA0 = SCL_RBG0_CHAR;  /* Place RBG0 bitmap data        */
       tp.vramA1 = SCL_RGB0_K;     /* Place rotate coeff. param.tbl.*/
       SCL_SetVramConfig(&tp);

       SCL_SetCycleTable(&cycle);
}
```

Title	Function	Function Name	No
Function Specification	Scroll open process	SCL_Open	8

Format void SCL_Open(Uint32 sclnum)
Input sclnum : Select the scroll screen number or 4 rotate parameter table normal screens (SCL_NBG0, SCL_NBG1, SCL_NBG2, SCL_NBG3), or rotate parameter table A, B (SCL_RBG_TB_A, SCL_RBG_TB_B).
Output None
Function Value None
Function Depending on the scroll screen selected, the following functions become available for use.

SCL_SetLineParam SCL_Move SCL_MoveTo
SCL_Scale SCL_Rotate SCL_RotateTo

Title	Function	Function Name	No
Function Specification	Scroll close process	SCL_Close	9

Format void SCL_Close(void)
Input None
Output None
Function Value None
Function Closes the functions selected with SclOpen().

Title	Function	Function Name	No
Function Specification	Initialize line and vertical cell scroll parameter table	SCL_InitLineParamTb	10

Format void SCL_InitLineParamTb(SclLineParam *lp)
Input lp : Line & vertical scroll parameter data
Output None
Function Value None
Function Initializes the line and cell scroll parameter table.

Title	Function	Function Name	No
Function Specification	Set line and vertical cell scroll parameters	SCL_SetLineParam	11

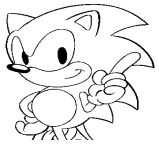
Format `void SCL_SetLineParam(SclLineParam *lp)`
Input lp : Line parameter table
Output None
Function Value None
Function None
Remarks Runs from the time that SclOpen() is executed until SclClose() is executed. It can only set NBG0, NBG1.

Title	Function	Function Name	No
Function Specification	Move scroll (Amount of move : absolute coord.)	SCL_MoveTo	12

Format `void SCL_MoveTo(Fixed32 x, Fixed32 y, Fized32 z)`
Input Indicates the coordinates of where to put the scroll screen.
x : X coordinates
y : Y coordinates
z : Z coordinates
Output None
Function Value None
Function Moves the scroll to absolute coordinates
Remarks Runs from the time that SclOpen() is executed until SclClose() is executed. The Z coordinate can only be used with the rotate parameter table.

Title	Function	Function Name	No
Function Specification	Move scroll (Amount of move : relative coord.)	SCL_Move	13

Format `void SCL_Move(Fixed32 x, Fixed32 y, Fized32 z)`
Input x : Indicates move distance in X direction
y : Indicates move distance in Y direction
z : Indicates move distance in Z direction
Output None
Function Value None
Function Moves the scroll relatively
Remarks Runs from the time that SclOpen() is executed until SclClose() is executed. The Z coordinate can only be used with the rotate parameter table.



Title	Function	Function Name	No
Function Specification	Enlarge or reduce scroll	SCL_Scale	14

Format `void SCL_Scale(Fixed32 sx, Fixed32 sy)`
Input sx : Size designation in the X direction
sy : Size designation in the Y direction
NBG0, NBG1 : 1/4~256
RBG0, RBG1 : Free
Output None
Function Value None
Function Scales the scroll screen.
Comments Runs from the time that SclOpen() is executed until SclClose() is executed. NBG2, NBG3 cannot be used.

Title	Function	Function Name	No
Function Specification	Initialize the rotation parameter table	SCL_InitRotateTable	15

Format `Uint32 SCL_InitRotateTable(Uint32 address, Uint16 num, Uint32 rotateA, Uint32 rotateB)`
Input address : Indicates the address to place the rotate parameter table.
num : Table Count
1 : Only uses rotate parameter A
2 : Uses rotate parameters A and B
rotateA : Select what to display using rotate parameter A.
SCL_SPR : Only display the sprite frame buffer
SCL_RBG0 : Display RBG0 and sprite frame buffer
SCL_NON : Do not display
rotateB : Select what to display using rotate parameter B.
SCL_RBG0 : Display RBG0
SCL_RBG1 : Display RBG1
SCL_ NON : Do not display
Output None
Function Value 0: Normal
1: Misallocation
2: Contradictions in the settings
Function Initializes the rotate parameter table and sets which location in VRAM to place the rotate parameter table.
Comments When using both rotate parameter tables A and B, screen repetition, XY axis rotate combination and Y axis rotation will not display correctly unless window display is designated.

Title	Function	Function Name	No
Function Specification	Set rotation view	SCL_SetRotateViewPoint	16

Format `void SCL_SetRotateViewPoint(Uint16 x, Uint16 y, Uint16 z)`
Input x : X coordinates
y : Y coordinates
z : Z coordinates
Output None
Function Value None
Function Sets the rotate viewpoint.
Comments Runs from the time that SclOpen() is executed until SclClose() is executed. SCL_NBG0~3 cannot be used.

Title	Function	Function Name	No
Function Specification	Set rotation center	SCL_SetRotateCenter	17

Format `void SCL_SetRotateCenterDisp(Uint16 x, Uint16 y)`
Input x : X coordinates
y : Y coordinates
z : Z coordinates
Output None
Function Value None
Function Sets the rotate center point.
Comments Runs from the time that SclOpen() is executed until SclClose() is executed. SCL_NBG0~3 cannot be used.

Title	Function	Function Name	No
Function Specification	Set the display rotate center coordinates	SCL_SetRotateCenterDisp	18

Format `void SCL_SetRotateCenter(Uint16 x, Uint16 y, Uint16 z)`
Input x : X coordinates
y : Y coordinates
Output None
Function Value None
Function Sets the display rotate center point.
Comments Runs from the time that SclOpen() is executed until SclClose() is executed. SCL_NBG0~3 cannot be used.

Title	Function	Function Name	No
Function Specification	Scroll rotate (angle : absolute coord.)	SCL_RotateTo	19

Format `void SCL_RotateTo(Fixed32 angelXy, Fixed32 angleZ, Fixed32 angleD, Uint16 mode)`

Input
- angelXy : Sets the X axis or Y axis angle
- angleZ : Sets the Z axis angle
- angleD : Sets the screen rotate angle
- mode : Rotate mode. Sets which axis, X or Y, to enable as the first argument.
  - SCL_X_AXIS : Rotate scroll X axis.
  - SCL_Y_AXIS : Rotate scroll Y axis. (Can't use with RBG1 screen designation.)

Output None

Function Value None

Function Rotate scroll screen.

Comments Runs from the time that SclOpen() is executed until SclClose() is executed. SCL_NBG0~3 cannot be used.

Title	Function	Function Name	No
Function Specification	Scroll rotate (angle : relative coord.)	SCL_Rotate	20

Format `void SCL_Rotate( Fixed32 angelXy, Fixed32 angleZ, Fixed32 angleD)`

Input
- angelXy : Sets the X axis or Y axis angle increase
- angleZ : Sets the Z axis angle increase
- angleD : Sets the screen rotate angle increase

Output None

Function Value None

Function Rotates the rotate scroll screen.

Comments Runs from the time that SclOpen() is executed until SclClose() is executed. SCL_NBG0~3 cannot be used.

Title	Function	Function Name	No
Function Specification	Set scale coefficient data in the rotate parameter coefficient table	SCL_SetCoefficientData	21

Format `void SCL_SetCoefficientData(Uint32, surface, Uint16 *datap, Uint16 x, Uint16 y)`

Input
- surface : Indicates which rotate parameter table to use for data set. (SCL_RBG_TB_A, SCL_RBG_TB_B)
- datap : Data table pointer.
- x : X data size
- y : Y data size

Output None

Function Value None

Function Sets scale coefficient data into the rotate coefficient table.

Title	Function	Function Name	No
Function Specification	Set mosaic process	SCL_SetMosaic	22

Format `void SCL_SetMosaic(Uint32 surface, Uint8 x, Uint8 y)`

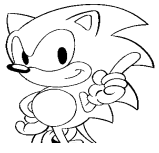
Input
- surface: Screen Type
  SCL_NBG0 | SCL_NBG1 |SCL_NBG2 | SCL_NBG3 | SCL_RBG0 | SCL_RBG1
- x : Horizontal size of the mosaic (0~15, 0 is mosaic off)
- y : Vertical size of the mosaic (0~15)
  Cannot set for rotate surface (RBG0, RBG1).

Output None

Function Value None

Function Sets the mosaic functions for each screen.

Comment If the mosaic process is used, the vertical cell scroll function cannot be used.



Title	Function	Function Name	No
Function Specification	Set line color screen data	SCL_SetLncl	23

Format: void SCL_Lncl(Uint32 address, Uint16 tbsize, Uint16 *palNumTb)

Input:
address : Location in VRAM to place the line color table
tbsize : Indicates the size of the table
PalNumTb : Indicates each line data with the palette number.

16 color	0~15
256 colors	0~255
2048 colors	0~2047

Output: None

Function Value: None

Function: Sets the line color screen data.

Comments: Set the pallet data into color RAM using the SCL_AllocRam() and SCL_SetColRam() beforehand.

Title	Function	Function Name	No
Function Specification	Set back screen data	SCL_SetBack	24

Format: void SCL_SetBack(Uint32 address, Uint16 dataSize, Uint16 *dataTb)

Input:
address : Location in VRAM to place the line color table
dataSize : Indicates the number of data tables
dataTb : Indicates each line data in 5bitRGB.

Output: None

Function Value: None

Function: Sets the back screen data and address.

Example: Sets back screen address in VRAM and sets the color to black.

```
void sample(void)
 {
        Uint16  DataTB;

        DataTB = 0x0000;      /* Black */
        SCL_SetBack(SCL_VDP2_VRAM, 1, &DataTB);
 }
```

Title	Function	Function Name	No
Function Specification	Set normal rectangle window	SCL_SetWindow	25

Format void SCL_SetWindow (Uint8 win, Uint32 logic, Uint32 enable, Uint32 area, Uint16 startX, Uint16 startY, Uint16 endX, Uint16 endY)

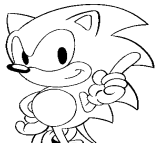
Input
win : Indicates the type of window.
SCL_W0: Indicates a W0 window
SCL_W1: Indicates a W1 window
logic : Here, layering of multiple windows on the screen is processed by AND. Default is OR.
enable : Indicates the screen to display the window on.
area : Indicates use of the outside area of a window, default is inside area.
The variables logic, enable and area can be calculated together by using OR.

Constant	logic	enable	area	Meaning
SCL_NBG0	○	○	○	Transparent process window NBG0
SCL_NBG1	○	○	○	Transparent process window NBG1
SCL_NBG2	○	○	○	Transparent process window NBG2
SCL_NBG3	○	○	○	Transparent process window NBG3
SCL_RBG0	○	○	○	Transparent process window RBG0
SCL_RBG1	○	○	○	Transparent process window RBG1
SCL_EXBG	○	○	○	Transparent process window EXBG
SCL_SPR	○	○	○	Transparent process window sprite
SCL_RP	○	Δ	○	Rotate parameter window
SCL_CC	○	○	○	Color calculation window
SCL_NON	○	○	○	Not indicated

○: Can be designated Δ: Cannot be designated on a sprite window

startX : Rectangle data start point X coordinate
startY : Rectangle data start point Y coordinate
endX : Rectangle data end point X coordinate
endY : Rectangle data end point Y coordinate

Output None
Function Value None
Function Sets normal rectangle windows.



Title	Function	Function Name	No
Function Specification	Set normal line window	SCL_SetLineWindow	26

Format: void SCL_SetLineWindow (Uint8 win, Uint32 logic, Uint32 enable, Uint32 area, Uint32 address, Uint32 sy, Uint32 tbSize, SclLineWindowTb *tb)

Input:
- win : Indicates the type of window
  - SCL_W0: Indicates a W0 window
  - SCL_W1: Indicates a w1 window
- logic : Here, layering of multiple windows on the screen is processed by AND. Default is OR.
- enable : Indicates the screen to display the window on.
- area : Indicates use of the outside area of a window, default is inside area.
- address : Location of the line window table in VRAM.
- sy : Lead Y coordinate.
- tbSize : Size of the line window table
- tb : Line window table pointer

The variables logic, enable and area can be calculated together by using OR.

Output: None

Function Value: None

Function: Sets normal line window.

Title	Function	Function Name	No
Function Specification	Set sprite window	SCL_SetSpriteWindow	27

Format: void SCL_SetSpriteWindow (Uint32 logic, Uint32 enable, Uint32 area)

Input:
- logic : Here, layering of multiple windows on the screen is processed by AND. Default is OR.
- enable : Indicates the screen to display the window on.
- area : Indicates use of the outside area of a window, default is inside area.

The variables logic, enable and area can be calculated together by using OR.

Output: None

Function Value: None

Function: Sets the sprite line window.

Comments: Sprites for the window must be prepared in advance using VDP1.

Title	Function	Function Name	No
Function Specification	Set different sprite modes	SCL_SetSpriteMode	28

Format void SCL_SetSpriteMode (Uint8 type, Uint8 colMode, Uint8 winMode)
Input type : Sprite type
SCL_SPR_TYPE0, SCL_SPR_TYPE1…SCL_SPR_TYPEF
colMode : Color mode
SCL_PALETTE, SCL_MIX
(SCL_MIX: palette and RGB mixture)
winMode: Window mode
SCL_MSB_SHADOW, SCL_SP_WINDOW
Output None
Function Value None
Function Sets the sprite type.

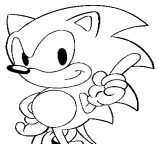
Title	Function	Function Name	No
Function Specification	Set color RAM mode	SCL_SetColRamMode	29

Format void SCL_SetColRamMode(Uint32 mode)
Input mode : Color RAM mode
SCL_CRM15_1024, SCL_CRM15_2048, SCL_CRM24_1024

Output None
Function Value None
Function Sets the color RAM mode.

Title	Function	Function Name	No
Function Specification	Get color RAM mode	SCL_GetColRamMode	30

Format Uint32 SCL_GetColRamMode(void)
Input None
Output None
Function Value Color RAM mode
SCL_CRM15_1024, SCL_CRM15_2048, SCL_CRM24_1024
Function Sets the color RAM mode.



Title	Function	Function Name	No
Function Specification	Set color RAM color data	SCL_SetColRam	31

Format: void SCL_SetColRam(Uint32 surface, Uint32 index, Uint32 num, void *color)

Input:
- surface : Screen type
  SCL_SPR, SCL_NBG0, SCL_NBG1, SCL_NBG2, SCL_NBG3, SCL_RBG0, SCL_RBG1, SCL_LNCL
- index : Write start palette number
- num : Size of the color data table
- color : Color data table (Unit 32 or Unit 16)

Output: None

Function Value: None

Function: Sets color data into the color RAM.

Comments: If using color RAM commonly, you can set just one of the screens if desired.

Title	Function	Function Name	No
Function Specification	Allocate area for color RAM	SCL_AllocColRam	32

Format: Uint32 SCL_AllocColRam(Uint32 surface, Uint32 numOfColors, Uint8 transparent)

Input:
- surface : Screen type
  SCL_SPR | SCL_NBG0 | SCL_NBG1 | SCL_NBG2 | SCL_NBG3 | SCL_RBG0 | SCL_RBG1 | SCL_LNCL
  Use OR calculation to use the same palette for multiple screens.
- numOfColors: Number of colors
- transparent: Sets whether to use transparent or not.
  - ON Palette 0 is not transparent
  - OFF Palette 0 is transparent

Output: None

Function Value: The lead allocated address

Function: Allocates the color RAM area.

Title	Function	Function Name	No
Function Specification	Free area allocated for color RAM	SCL_FreeColRam	33

Format: void SCL_FreeColRam(Uint32 surface)

Input:
- surface : Screen type
  SCL_SPR | SCL_NBG0 | SCL_NBG1 | SCL_NBG2 | SCL_NBG3 | SCL_RBG0 | SCL_RBG1
  Use OR calculation to use the same palette for multiple screens.

Output: None

Function Value: None

Function: Frees the area allocated for color RAM.

Title	Function	Function Name	No
Function Specification	Set auto color change	SCL_SetAutoColChg	34

Format: void SCL_SetAutoColChg (Uint32 surface, Uint32 interval, Uint32 index, Uint32 numOfCol, Uint32 numOfTbl, Uint32 changeTbl[])

Input:
surface : Screen type
SCL_SPR, SCL_NBG0, SCL_NBG1, SCL_NBG2, SCL_NBG3, SCL_RBG0, SCL_RBG1
interval : Interval
designated in units of 1/60th of a second
index : Start palette number to be changed
numOfCol: Number of colors
numOfTbl: Number of Tables
changeTbl[]: Change tables

Output: None

Function Value: None

Function: Changes a portion of each pallet a little at a time towards a specific color. The number of pallets is limited to 256 colors. It is not compatible with 2048, or 1024 colors.

Title	Function	Function Name	No
Function Specification	Get the color RAM address offset	SCL_GetColRamOffset	35

Format: Uint32 = SCL_GetColRamOffset(Uint32 surface)

Input:
surface : Screen type
SCL_SPR, SCL_NBG0, SCL_NBG1, SCL_NBG2, SCL_NBG3, SCL_RBG0, SCL_RBG1

Output: None

Function Value: Offset address from the VDP2 VRAM.

Function: Gets the color RAM address offset.

Title	Function	Function Name	No
Function Specification	Set priorities	SCL_SetPriority	36

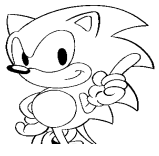
Format: void SCL_SetPriority(Uint32 surface, Uint8 priority)

Input:
surfaces : Screen types
SCL_SP0|SCL_SP1…SCLSP7|SCL_NBG0|SCL_NBG1|SCL_NBG2|SCL_NBG3|SCL_RBG0|SCL_RBG1|SCL_EXBG
priority : Priority number

Output: None

Function Value: None

Function: Sets the priority.



Title	Function	Function Name	No
Function Specification	Get priorities	SCL_GetPriority	37

Format Uint8 Priority = SCL_GetPriority(Uint32 surface)
Input surfaces : Screen types
SCL_SPR, SCL_NBG0, SCL_NBG1, SCL_NBG2, SCL_NBG3, SCL_RBG0, SCL_RBG1, SCL_EXBG
priority : Priority number
Output None
Function Value None
Function Gets the priority.

Title	Function	Function Name	No
Function Specification	Set color calculation conditions (SPRITE)	SCL_SetColMixMode	38

Format void SCL_SetColMixMode(Uint32 colMixPriority, Uint8 mode)
Input colMixPriority : Sprite priority number
0~7
mode : Mode
SCL_IF_FRONT, SCL_IF_EQUAL, SCL_IF_BEHIND
Output None
Function Value None
Function Sets the color calculation conditions.

Title	Function	Function Name	No
Function Specification	Set color calculation mix	SCL_SetColMixRate	39

Format void SCL_SetColMixRate(Uint32 surfaces, Uint8 rate)
Input surfaces : Screen types
SCL_SP0|SCL_SP1…SCL_SP7|SCL_NBG0|SCL_NBG1|SCL_NBG2|SCL_NBG3|SCL_RBG0,|SCL_RBG1|SCL_EXBG
Use OR calculation to use the same palette for multiple screens
rate : Rate
0~31
Output None
Function Value None
Function Sets the color calculation rate.

Title	Function	Function Name	No
Function Specification	Set auto color calculation	SCL_SetAutoColMix	40

Format: void SCL_SetAutoColMix(Uint32 surfaces, Uint32 interval, Uint32 time, uint8 startRate, Uint8 endRate)

Input:
surfaces : Screen types
SCL_SP0|SCL_SP1…SCL_SP7|SCL_NBG0|SCL_NBG1|SCL_NBG2|SCL_NBG3|SCL_RBG0,|SCL_RBG1|SCL_EXBG
Use OR calculation to use the same palette for multiple screens
interval : Interval
Designated in units of 1/60th of a second.
time : Indicates the time to complete the color change.
Designated in units of 1/60th of a second.
startRate : Rate at the starting point
endRate : Rate at the ending point

Output: None

Function Value: None

Function: Changes the color mix according the designated time or interval.

Title	Function	Function Name	No
Function Specification	Set color offset	SCL_SetColOffset	41

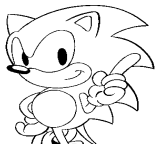
Format: void SCL_SetColOffset(Uint32 offsetreg, Uint32 surfaces, Sint16 red, Sint16 green, Sint16 blue)

Input:
offsetreg : Indicates which color offset register to use.
SCL_OFFSET_A, SCL_OFFSET_B
surfaces : Screen types
SCL_SP0|SCL_SP1…SCL_SP7|SCL_NBG0|SCL_NBG1|SCL_NBG2|SCL_NBG3|SCL_RBG0|SCL_RBG1|SCL_EXBG
Use OR calculation to use the same palette for multiple screens
Red : Color indicator (red)
green : Color indicator (green)
blue : Color indicator (blue)

Output: None

Function Value: None

Function: Sets the color offset.



Title	Function	Function Name	No
Function Specification	Increase/decrease the color offset value	SCL_IncColOffset	42

Format `void SCL_IncColOffset(Uint16 offsetReg, Sint16 red, Sint16 green, Sint16 blue)`

Input
offsetreg : Indicates which color offset register to use.
SCL_OFFSET_A, SCL_SCL_OFFSET_B
red : Color indicator (red) -255~255
green : Color indicator (green) -255~255
blue : Color indicator (blue) -255~255

Output None

Function Value None

Function Increases/decrease the color offset values.

Title	Function	Function Name	No
Function Specification	Set the auto color offset	SCL_SetAutoColOffset	43

Format `void SCL_SetAutoColOffset (Uint32 offsetReg, Uint32 interval, Uint32 time, SclRgb *start, SclRgb *end)`

Input
offsetreg : Indicates which color offset register to use.
SCL_OFFSET_A, SCL_OFFSET_B
interval : Interval
Designated in units of 1/60th of a second.
time : Indicates the time to complete the color change.
Designated in units of 1/60th of a second.
start : Start color indicator (red) -255~255
: Start color indicator (green) -255~255
: Start color indicator (blue) -255~255
end : End color indicator (red) -255~255
: End color indicator (green) -255~255
: End color indicator (blue) -255~255

Output None

Function Value None

Function Changes the color offset according to the designated time or interval.

Title	Function	Function Name	No
Function Specification	Enable blur calculations	SCL_EnableBlur	44

Format void SCL_EnableBlur(Uint32 surface)
Input surfaces : Screen types
SCL_SPR, SCL_NBG0, SCL_NBG1, SCL_NBG2, SCL_NBG3,
SCL_RBG0, SCL_RBG1, SCL_EXBG
Output None
Function Value None
Function Enables blur calculations.

Title	Function	Function Name	No
Function Specification	Disable blur calculations	SCL_DisableBlur	45

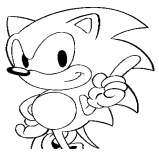
Format void SCL_DisableBlur(void)
Input None
Output None
Function Value None
Function Disables blur calculations.

Title	Function	Function Name	No
Function Specification	Bring in line color screen	SCL_EnableLineCol	46

Format void SCL_EnableLineCol(Uint32 surface);
Input surfaces : Screen types
SCL_SPR, SCL_NBG0, SCL_NBG1, SCL_NBG2, SCL_NBG3,
SCL_RBG0, SCL_RBG1, SCL_EXBG
Output None
Function Value None
Function Brings in line color screens.

Title	Function	Function Name	No
Function Specification	Disable line color screen	SCL_DisableLineCol	47

Format void SCL_DisableLineCol(Uint32 surface);
Input surfaces : Screen types
SCL_SPR, SCL_NBG0, SCL_NBG1, SCL_NBG2, SCL_NBG3,
SCL_RBG0, SCL_RBG1, SCL_EXBG
Output None
Function Value None
Function Disables line color screens.



Title	Function	Function Name	No
Function Specification	Set shadow bit	SCL_SetShadowBit	48

Format: void SCL_SetShadowBit(Uint32 enable);

Input: enable : Indicates which screen will have shadow. Use OR to indicate multiple screens simultaneously.
SCL_NBG0 | SCL_NBG1 | SCL_NBG2 | SCL_NBG3 | SCL_RBG0 | SCL_RBG1 | SCL_BACK | SCL_EXBG | SCL_NON

Output: None

Function Value: None

Function: Sets the shows bit.

Comments: Shadow sprites must be prepared in advance using VDP1.

Title	Function	Function Name	No
Function Specification	Set frame change interval count	SCL_SetFrameInterval	49

Format: void SCL_SetFrameInterval(Uint16 count)

Input: count : V-BLANK interval count

Output: None

Function Value: None

Function: Sets the frame change interval count.
The interval count values have the following meanings.

0 = Frame change is set to auto change mode and the interval count to 1. Cannot be synchronous with SCL_DisplayFrame().

1 = Frame change is set to auto change mode and the interval count to 1. Can be synchronous with SCL_DisplayFrame().

0xffff = Frame change is set to undefined interval manual change mode. Confirms VDP1 draw end before frame change.

0xfffe = Undefined interval manual change mode through V-BLANK erase. Changes frame without confirming VDP1 draw end.

Other = Frame change is set to defined interval manual change mode through the designated interval count.
b15=0: Does erase write.
=1: Does not erase write.

Title	Function	Function Name	No
Function Specification	Wait for frame change request to end	SCL_DisplayFrame	50

Format: void SCL_DisplayFrame(void)

Input: None

Output: None

Function Value: None

Function: Turns on the frame change request flag and waits for the V-BLANK interrupt routine sprite and scroll frame display to end.

Title	Function	Function Name	No
Function Specification	V-BLANK start VDP interrupt processing	SCL_VblankStart	51

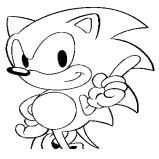
Format `void SCL_VblankStart(void)`
Input None
Output None
Function Value None
Function VDP1, 2 display V-BLANK start processing (scroll parameter set, etc.).

Title	Function	Function Name	No
Function Specification	V-BLANK end VDP interrupt processing	SCL_VblankEnd	52

Format `void SCL_VblankEnd(void)`
Input None
Output None
Function Value None
Function VDP1, 2 display V-BLANK end processing (scroll parameter set, etc.).

Title	Function	Function Name	No
Function Specification	Force abort of automatic VE	SCL_AbortAutoVE	53

Format `void SCL_AbortAutoVE(void)`
Input None
Output None
Function Value None
Function Forced abort of automatic VE.



Mathematical Calculation Library

1.0 Guide

1.1 Objective

The mathematical calculation library is a group of routines designed to simplify 3D display, 3D object move calculations, 32-bit fixed decimal calculations, etc.
These routines are separated into the following categories.

- Triangle Functions
  Sin, cos values are pulled from the table. Tables are recorded once each, and between each is a straight line complement.

- Matrix Calculation Processing
  Used for matrix stack control and matrix combination processing.

- 3D Coordinate Conversion Processing through the DSP
  The polygon data hide surface determination, brightness calculation and coordinate conversion process used by the sprite 3D display library are all done together by the DSP.

- Perspective Conversion Process
  Perspective conversion is done using the view coordinate system to convert from 3D to 2D screen. The view point position is the origin point and the screen position is the Z axis -1.0 position.

- Random Number Generator
  Generates random numbers with a range of 0 to 0xffffffff that are used in games.

- Spline Curve Calculation
  This curve calculation function is used to calculate 3D spline curves and has the following characteristics.
  1) Supports both 2D and 3D coordinate systems.
  2) Can get the output coordinate connecting vectors.

  As shown in Figure 1, by just specifying a few points, the curve that passes through those points can be extrapolated. In Figure 1, the input coordinates are P0~3; by entering the number of points to be entered, four, and the number of points wanted, 10, then the output coordinates that pass through those points are shown by c0~c9. Also, by using a connecting line function, the connecting vector of the output coordinates can be obtained. Connecting line vectors can be used for character direction, etc.

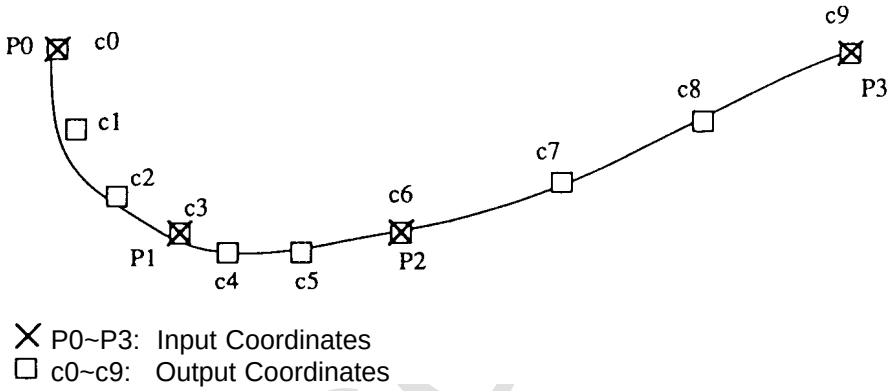
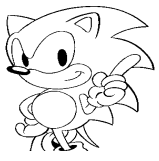


Figure 1 Curve Calculation Diagram

- Fixed Point Calculation
  There are routines and macros for 32-bit fixed point data (16 bit integer + 16 bit decimal), multiplication and division calculations, and integer, floating point data compatibility conversion.

- Other Functions
  Calculation function other than that listed above.



2.0 Reference

2.1 Data Specifications

Title	Data	Data Name	No
Data Specification	2D Point Data	MthXy	

```
typedef struct MthXy  {
      Fixed32 x;        /* X Coordinate */
      Fixed32 y;        /* Y Coordinate */
}  NthXy;
```

Title	Data	Data Name	No
Data Specification	3D Data Structure	MthXyz	

```
typedef struct MthXyz  {
      Fixed32 x;        /* X Coordinate */
      Fixed32 y;        /* Y Coordinate */
      Fixed32 z;        /* Z Coordinate */
}  MthXyz;
```

Title	Data	Data Name	No
Data Specification	3 Line, 4 Column Matrix Data	MthMatrix	

```
typedef struct MthMatrix  {
      Fixed32 val[3][4];    /* 3 line, 4 column fixed point data */
}  MthMatrix
```

Title	Data	Data Name	No
Data Specification	Matrix Stack Table	MthMatrixTbl	

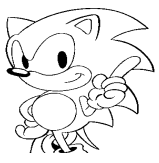
```
typedef struct MthMatrixTbl  {
      Uint16      stackSize; /* Matrix stack entries          */
      MthMatrix   *current;  /* Current matrix pointer        */
      MthMatrix   *stack;    /* Matrix stack pointer          */
}  MthMatrixTbl;
```

Title	Data	Data Name	No
Data Specification	Polygon Data Coordinate Conversion Parameter	MthPolyTransParm	

```
typedef struct MthPolyTransParm  {
   MthViewLight  *viewLight; /* Coord. system conversion parameters   */
   Uint32  surfCount;        /* Polygon surfaces                      */
   MthXyz  *surfPoint;    /* Point on polygon for brightness calculation*/
   MthXyz  *surfNormal;      /* Polygon surface lines                 */
   Sint32  *surfBright;      /* Polygon surface brightness calc. results*/
   Uint32  transViewVertCount;  /* View conversion vertex entries     */
   MthXyz  *transViewVertSrc;   /* Vertex data before view conversion  */
   MthXyz  *transViewVertAns;   /* Vertex data after view conversion   */
   Uint32  gourVertCount;    /* Vertex point brightness vertex entries */
   MthXyz  *vertNormal;      /* Vertex point brightness calc. normal   */
   Sint32  *vertBright;      /* Vertex point brightness calc. reults   */
   Uint32  transWorldVertCount; /* World coord. conversion vertex entries */
   MthXyz  *transWorldVertSrc;  /* Vertex data before World conversion  */
   MthXyz  *transWorldVertAns;  /* Vertex data after World conversion   */
}  MthPolyTransParm;
```

Title	Data	Data Name	No
Data Specification	Coordinate System Conversion Parameters	MthViewLight	

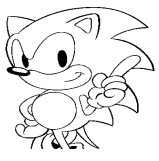
```
typedef struct MthViewLight  {
      MthMatrix viewMatrix;   /* Conversion matrix to view coordinates */
      MthXyz    lightVector; /* Light source toggle in view coord. sys*/
      MthMatrix worldMatrix;  /* Conversion matrix to world coord. sys.*/
}  MthViewLight;
```

2.2 List of Functions

Function	Function Name	Number
<Triangle Functions>		
sin function	MTH_Sin	1
cos function	MTH_Cos	2
atan function	MTH_Atan	3
<Matrix Calculation>		
Initialize matrix stack	MTH_InitialMatrix	4
Clear current matrix	MTH_ClearMatrix	5
Push matrix	MTH_PushMatrix	6
Pop matrix	MTH_PopMatrix	7
Combine matrix and move horizontally	MTH_MoveMatrix	8
Combine matrix and rotate X	MTH_RotateMatrixX	9
Combine matrix and rotate Y	MTH_RotateMatrixY	10
Combine matrix and rotate Z	MTH_RotateMatrixZ	11
Combine matrix and reverse Z	MTH_ReverseZ	12
Matrix calculation and multiplication	MTH_MulMatrix	13
Matrix calculation and vertex coordinate conversion	MTH_CordTrans	14
Matrix calculation, line toggle coordinate conversion	MTH_NormalTrans	15
<3D Polygon Data Coordinate Conversion through the DSP>		
Initialize Coordinate Conversion Process	MTH_PolyDataTransInit	16
Execute the Coordinate Conversion Process	MTH_PolyDataTansExec	17
Check the Coordinate Conversion Process	MTH_PolyDataTransCheck	18
<Perspective Conversion>		
3D perspective conversion	MTH_Pers2D	19
<Random Number Generator>		
Initialize the Random Number Generator	MTH_InitialRand	20
Get Random Number	MTH_GetRand	21
<Spline Curve Calculation>		
Curve calculation, work area definition macro	MTH_INIT_CURVE	22
Curve calculation, 2D	MTH_Curve2	23
Curve calculation, 2D with tangent	MTH_Curve2t	24
Curve calculation, 3D	MTH_Curve3	25
Curve calculation, 3D with tangent	MTH_Curve3t	26

Function		Function Name	Number
<Fixed Point Calculations>			
	Multiplication Routine	`MTH_Mul`	27
	Division routine	`MTH_Div`	28
	Fixed to floating point conversion macro	`MTH_FLOAT`	29
	Floating to fixed point conversion macro	`MTH_FIXED`	30
	Integer to fixed conversion routine	`MTH_IntToFixed`	31
	Fixed to integer conversion routine	`MTH_FixedToInt`	32
	3 item sum of product calculation	`MTH_Product`	33
<Other Functions>			
	Square Root	`MTH_Sqrt`	34
	Hypotenuse calculation of a right angle triangle	`MTH_Hypot`	35
	Surface normal vector calculation	`MTH_CompateNormVect`	36



2.3 Function Specifications

<Triangle Functions>

Title	Function	Function Name	No
Function Specification	sin function	MTH_Sin	1

Format Fixed32 val = MTH_Sin(Fixed32 degree)
Input degree : Angles from -180.0 to 180.0
Output None
Function Value val : sin value
Function Returns the sin value of the indicated angle.

Title	Function	Function Name	No
Function Specification	cos function	MTH_Cos	2

Format Fixed32 val = MTH_Cos(Fixed32 degree)
Input degree : Angles from -180.0 to 180.0
Output None
Function Value val : cos value
Function Returns the cos value of the indicated angle.

Title	Function	Function Name	No
Function Specification	atan function	MTH_Atan	3

Format Fixed32 degree = MTH_Atan(Fixed32 y, Fixed32 x)
Input y : Height from -1.0 to 1.0
x : Base from -1.0 to 1.0
Output None
Function Value degree : Angles from -180.0 to 180.0
Function Returns the atan value from the indicated x, y values.

Title	Function	Function Name	No
Function Specification	Initialize matrix stack	MTH_InitialMatrix	4

Format: void MTH_InitialMatrix (MthMatrixTbl *matrixTbl, Uint16 stackSize, MthMatrix *matrix)
Input: matrixTbl : Matrix table
stackSize : Maximum entries on a matrix stack
matrix : Matrix stack area
Output: matrixTbl : Matrix table
Function Value: None
Function: Initializes the matrix table.

Title	Function	Function Name	No
Function Specification	Clear current matrix	MTH_ClearMatrix	5

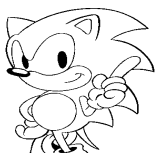
Format: void MTH_ClearMatrix(MthMatrixTbl *matrixTbl)
Input: matrixTbl : Matrix table
Output: None
Function Value: None
Function: Clears the current matrix to a unit matrix.

Title	Function	Function Name	No
Function Specification	Push matrix	MTH_PushMatrix	6

Format: void MTH_PushMatrix(MthMatrixTbl *matrixTbl)
Input: matrixTbl : Matrix table
Output: None
Function Value: None
Function: Pushes the current matrix.

Title	Function	Function Name	No
Function Specification	Pop matrix	MTH_PopMatrix	7

Format: void MTH_PopMatrix(MthMatrixTbl *matrixTbl)
Input: matrixTbl : Matrix table
Output: None
Function Value: None
Function: Pops the current matrix.



Title	Function	Function Name	No
Function Specification	Combine matrix and move horizontally	MTH_MoveMatrix	8

Format `void MTH_MoveMatrix(MthMatrixTbl *matrixTbl, Fixed32 x, Fixed32 y, Fixed32 z)`
Input matrixTbl : Matrix table
x : Amount to move in X direction
y : Amount to move in Y direction
z : Amount to move in Z direction
Output None
Function Value None
Function Combines the matrix for a horizontal move in the XYZ direction for the current matrix.

Title	Function	Function Name	No
Function Specification	Combine matrix and rotate X	MTH_RotateMatrixX	9

Format `void MTH_RotateMatrixX (MthMatrixTbl *matrixTbl, Fixed32 xDegree)`
Input matrixTbl : Matrix table
xDegree : X axis rotation angle (Range from -180.0 to 180.0)
Output None
Function Value None
Function Combines the matrix for X axis rotation for the current matrix.

Title	Function	Function Name	No
Function Specification	Combine matrix and rotate Y	MTH_RotateMatrixX	10

Format `void MTH_RotateMatrixY (MthMatrixTbl *matrixTbl, Fixed32 yDegree)`
Input matrixTbl : Matrix table
yDegree : Y axis rotation angle (Range from -180.0 to 180.0)
Output None
Function Value None
Function Combines the matrix for Y axis rotation for the current matrix.

Title	Function	Function Name	No
Function Specification	Combine matrix and rotate Z	MTH_RotateMatrixZ	11

Format `void MTH_RotateMatrixZ (MthMatrixTbl *matrixTbl, Fixed32 zDegree)`
Input matrixTbl : Matrix table
zDegree : Z axis rotation angle (Range from -180.0 to 180.0)
Output None
Function Value None
Function Combines the matrix for Z axis rotation for the current matrix.

Title	Function	Function Name	No
Function Specification	Combine matrix and reverse Z	MTH_ReverseZ	12

Format void MTH_ReverseZ(MthMatrixTbl *matrixTbl)
Input matrixTbl : Matrix table
Output None
Function Value None
Function Combines the current matrix for Z axis reversal.

Title	Function	Function Name	No
Function Specification	Matrix calculation, multiplication	MTH_MulMatrix	13

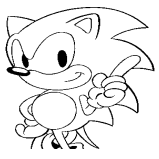
Format void MTH_MulMatrix(MthMatrix *a, MthMatrix *b, MthMatrix *c)
Input a : Multiplicand matrix
b : Multiplier matrix
Output c : Multiplication results matrix
Function Value None
Function Multiplies matrix a and b and outputs the result to c.

Title	Function	Function Name	No
Function Specification	Matrix calculation, vertex coordinate conversion	MTH_CordTrans	14

Format void MTH_CoordTrans (MthMatrix *matrix, MthXyz *src, MthXyz *ans)
Input matrix : Conversion matrix
src : Vertex coordinates before conversion
Output ans : Vertex coordinates after conversion
Function Value None
Function Converts vertex coordinates in the conversion matrix.

Title	Function	Function Name	No
Function Specification	Matrix calculation, normal vector coordinate conversion	MTH_NormalTrans	15

Format void MTH_NormalTrans (MthMatrix *matrix, MthXyz *src, MthXyz *ans)
Input matrix : Conversion matrix
src : Normal vector before conversion
Output ans : Normal vector after conversion
Function Value None
Function Converts normal vector in the conversion matrix.



<3D Polygon Data Coordinate Conversion through the DSP>

Title	Function	Function Name	No
Function Specification	Initialize Coordinate Conversion Process	MTH_PolyDataTransInit	16

Format `void MTH_PolyDataTransInit(void)`
Input None
Output None
Function Value None
Function Initializes the DSP and loads the coordinate conversion program.

Title	Function	Function Name	No
Function Specification	3D Polygon Data Coordinate Conversion	MTH_PolyDataTransExec	17

Format `void MTH_PolyDataTransExec( MthPolyTransParm *polyTransParm)`
Input polyTransParm: Coordinate conversion parameter table
Output PolyTransParm: The areas below are output from the coordinate conversion table.

surfBright	Polygon surface brightness calc. results
transViewVertAns	Vertex data after view conversion
vertBright	Vertex point brightness calc. results
transWorldVertAns	Vertex data after World conversion

Function Value None
Function The DSP runs the following continuous process of an example of polygon data (3D object) used by the 3D sprite display library.

· Polygon Surface Hide Determine and Brightness Calculation
– Related Parameters –

<Input>	surfCount	Polygon surfaces
	surfPoint	Point on polygon for bright calculation
	surfNormal	Polygon surface normal
	matrix	Conversion matrix to view coordinates
	light Vector	Light source vector in the view coord. system
<Output>	surfBright	Polygon surface brightness calc. results
	6_{31}	=1: Hide surface
		=0: Show surface
	b_4-b_0	=0x00: Darkest
	0x1f	=0x1f: Lightest

· Conversion to the Vertex Coordinate System
– Related Parameters –

<Input>	transViewVertCount	View conversion vertex entries
	transViewVertSrc	Vertex data before view conversion
	viewMatrix	Conversion matrix to the view coord. system
<Output>	transViewVertAns	Vertex data after view conversion

· Gouraud Display Vertex Brightness Calculation
– Related Parameters –

<Input>	gourVertCount	Vertex point brightness vertex entries If = 0, then brightness not calculated
	vertNormal	Vertex point brightness calc. normal table
	matrix	Conversion matrix to view coordinates
	lightVector	Light source vector in the view coord. sys.
<Output>	vertBright	Vertex brightness calculation results table 0x00 = Darkest 0x1f = Lightest

· Conversion to the Vertex World Coordinate System
– Related Parameters –

<Input>	transWorldVertCount	Vertex data before World conversion If = 0, conversion to world not executed.
	transWorldVertSrc	Vertex data table before world coord. conversion
	worldMatrix	Conversion matrix to world coordinates
<Output>	transWorldVertAns	Vertex data table after conversion to world coordinate system

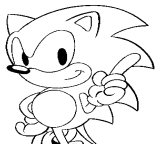
Title	Function	Function Name	No
Function Specification	Check the Coordinate Conversion Process	MTH_PolyDataTansCheck	18

Format `void MTH_PolyDataTransCheck(void)`
Input None
Output None
Function Value None
Function Waits until the DSP coordinate conversion process is finished.

<Perspective Conversion>

Title	Function	Function Name	No
Function Specification	3D perspective conversion	MTH_Pers2D	19

Format `void MTH_Pers2D (MthXyz *p3d, MthXy *unitPixel, XyInit *p2d)`
Input p3d : View coordinate system 3D vertex coordinates
unitPixel : Screen XY unit pixels
Output p2d : 2D screen coordinates after perspective conversion
Function Value None
Function Converts from 3D to 2D perspective by setting the screen to -1.0 as the view of the coordinate system base point. The size of 1.0 on the screen corresponds to the XY unit pixels.



<Random Number Generator>

Title	Function	Function Name	No
Function Specification	Initialize the Random Number Generator	MTH_InitialRand	20

Format	`void MTH_InitalRand(Uint32 initVal)`
Input	initVal : Initial parameter value of the random number generator
Output	None
Function Value	None
Function	Sets the initial parameter for calculation of the random number returned by MTH_GetRand. Unless this routine is called, the initial value of the random number generator will be 0.

Title	Function	Function Name	No
Function Specification	Get Random Number	MTH_GetRand	21

Format	`Uint32 randVal = MTH_GetRand(void)`
Input	None
Output	None
Function Value	randVal : Generates a random number from 0x00000000 to 0xffffffff.
Function	Returns a random number each time it is run.

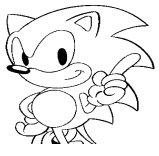
<Spline Curve Calculation>

Title	Function	Function Name	No
Function Specification	Curve calculation, work area definition macro	MTH_INIT_CURVE	22

Format MTH_INIT_CURVEWORK(WORK_AREA, POINT_MAX)
Input WORK_AREA : Work area name
POINT_MAX : Maximum input points
Function Defines as user area the area needed to execute the curve calculation function. This definition area pointer is returned to each curve calculation function as a parameter.
The area reserved is the maximum input points x 36bytes.
The count of the output coordinate is (in_n - 1) *step+ 1, so prepare an aray larger than that size.

Title	Function	Function Name	No
Function Specification	2D	MTH_Curve2	23

Format Uint32 count = MTH_Curve2(MthCurveWork *work, MthXy *in_aray, Uint32 in_n, Uint32 out_n, MthXy *out_aray)
Input work : Work area pointer
in_aray : Input coordinate aray
in_n : Input coordinate count
out_n : Output coordinate count
Output out_aray : Output coordinate aray
Function Value count : More than 2 output coordinates 0: parameter error
Function work indicates the work area reserved by the MTH_INIT_CURVE macro.
- in_aray indicates the pointer to input coordinates that pass through the curve.
- in_n indicates the number in in_aray. Please indicate more than 3.
- out_n indicates the number in out_aray. Please indicate more than 2.
- out_aray indicates the pointer that receives the calculation results. It returns the aray of the output coordinates that pass through the curve.



Title	Function	Function Name	No
Function Specification	Curve calculation, 2D with connectors	MTH_Curve2t	24

Format
```
Uint32 count = MTH_Curve2(MthCurveWork *work, MthXy *in_aray,
Uint32 in_n, Uint32 out_n, MthXy *out_aray MthXy *tan_aray)
```
Input
work : Work area pointer
in_aray : Input coordinate aray
in_n : Input coordinate count
out_n : Output coordinate count
Output
out_aray : Output coordinate aray
tan_aray : Connector line toggle of each output coordinates
Function Value
count : More than 2 output coordinates 0: parameter error
Function
work indicates the work area reserved by the MTH_INIT_CURVE macro.
- in_aray indicates the pointer to input coordinates that pass through the curve.
- in_n indicates the number in in_aray. Indicate more than 3.
- bout_n indicates the number in out_aray. Indicate more than 2.
- out_aray indicates the pointer that receives the calculation results. It returns the aray of the output coordinates that pass through the curve.
- tan_aray returns the tangent vector toggle that shows the direction of progress for each output coordinate. The size of the tangent vector is 1.0.

Title	Function	Function Name	No
Function Specification	3D	MTH_Curve3	25

Format
```
Uint32 count = MTH_Curve3(MthCurveWork *work, MthXyz *in_aray,
Uint32 in_n, Uint32 out_n, MthXyz *out_aray)
```
Input
work : Work area pointer
in_aray : Input coordinate aray
in_n : Input coordinate count
out_n : Output coordinate count
Output
out_aray : Output coordinate aray
Function Value
count : More than 2 output coordinates 0: parameter error
Function
work indicates the work area reserved by the MTH_INIT_CURVE macro.
- in_aray indicates the pointer to input coordinates that pass through the curve.
- in_n indicates the number in in_aray. Indicate more than 3.
- out_n indicates the number in out_aray. Indicate more than 2.
- out_aray indicates the pointer that receives the calculation results. It returns the aray of the output coordinates that pass through the curve.

Title	Function	Function Name	No
Function Specification	Curve calculation, 3D with tangent	MTH_Cruve3t	26

Format Uint32 count = MTH_Curve3t(MthCurveWork *work, MthXyz *in_aray, Uint32 in_n, Uint32 out_n, MthXyz *out_aray, MthXyz *tan_aray)

Input
work : Work area pointer
in_aray : Input coordinate aray
in_n : Input coordinate count
out_n : Output coordinate count

Output
out_aray : Output coordinate aray
tan_aray : Tangent vector toggle of each output coordinates

Function Value
count : More than 2 output coordinates 0: parameter error

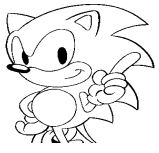
Function
work indicates the work area reserved by the MTH_INIT_CURVE macro.
- in_aray indicates the pointer to input coordinates that pass through the curve.
- in_n indicates the number in in_aray. Indicate more than 3.
- out_n indicates the number in out_aray. Indicate more than 2.
- out_aray indicates the pointer that receives the calculation results. It returns the aray of the output coordinates that pass through the curve.
- tan_aray returns the tangent vector toggle that shows the direction of progress for each output coordinate. The size of tangent vector is 1.0.

Cautions on Use

These curve calculation functions were developed with process speed as a top priority, so there is no overflow check. But, if a large number is encountered during function calculation, an overflow will occur. The allowable range of input data is as follows:

- Distance between points: more than 0.1.
- Point coordinate value range: between -1000 and 1000.

Also, because of possible algorithm changes in future versions, the same output coordinates may not be produced with the same parameters.



Title	Function	Function Name	No
Function Specification	Multiplication Routine	MTH_Mul	27

Format `Fixed32 result = MTH_Mul(Fixed32 a, Fixed32 b)`
Input a : Multiplicand
b : Multiplier
Output None
Function Value result : Multiplication results
Function Does fixed point multiplication.

Title	Function	Function Name	No
Function Specification	Division routine	MTH_Div	28

Format `Fixed32 result = MTH_Div(Fixed32 a, Fixed32 b)`
Input a : Dividend
b : Divisor
Output None
Function Value result : Division results
Function Does fixed point division.

Title	Function	Function Name	No
Function Specification	Fixed to floating point conversion macro	MTH_FLOAT	29

Format `Float b = MTH_FLOAT(Fixed32 a)`
Input a : Fixed point data
Output None
Function Value b : Conversion results to floating point format.
Function Macro to convert fixed point data to floating point data.

Title	Function	Function Name	No
Function Specification	Floating to fixed point conversion macro	MTH_FIXED	30

Format `Fixed32 b = MTH_FIXED(Float a)`
Input a : Floating point data
Output None
Function Value b : Conversion results to fixed point format.
Function Macro to convert floating point data to fixed point data.

Title	Function	Function Name	No
Function Specification	Integer to fixed conversion routine	MTH_IntToFixed	31

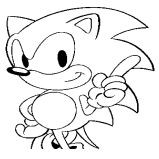
Format `Fixed32 b = MTH_IntToFixed(Sint32 a);`
Input a : Integer data
Output None
Function Value b : Conversion results to fixed point data.
Function Macro to convert integer data to fixed point data.

Title	Function	Function Name	No
Function Specification	Fixed to integer conversion routine	MTH_FixedToInt	32

Format `Sint32 b = MTH_FixedToInt(Fixed a)`
Input a : Fixed point data
Output None
Function Value b : Conversion results to integer data format.
Function Macro to convert fixed point data to integer data.

Title	Function	Function Name	No
Function Specification	3 item sum of product calculation	MTH_Product	33

Format `Fixed32 result = MTH_Product(Fixed32 *a, Fixed32 *b)`
Input a : 3 Multiplicand data lines
b : 3 multiplier data lines
Output None
Function Value results : Product sum of the multiplication results
Function Does calculation processing as follows:
result = a[0]*b[0] + a[1]*b[1] + a[2]*b[2]



<Other Functions>

Title	Function	Function Name	No
Function Specification	Square Root	MTH_Sqrt	34

Format `Fixed32 result = MTH_Sqrt(Fixed32x)`
Input x : Correct fixed point real number value
Output None
Function Value result : Calculated square root value
Function Calculates and returns the square root of the input value.

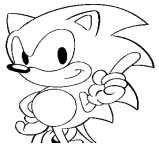
Title	Function	Function Name	No
Function Specification	Hypotenuse calculation of a right angle triangle	MTH_Hypot	35

Format `Fixed32 z = MTH_Hypot(Fixed32 x, Fixed32 y)`
Input x : Right angle triangle base length
y : Right angle triangle perpendicular length
Output None
Function Value z : Hypotenuse length of the right angle triangle
Function Returns z that fulfills the following equation.
$z^2=x^2+y^2$ but $z \geq 0$

Title	Function	Function Name	No
Function Specification	Surface normal vector calculation	MTH_ComputeNormVect	36

Format `void MTH_ComputeNormVect (Fixed32 surfNormK, MthXyz *p0, MthXyz *p1, MthXyz *p3, MthXyz *normal)`
Input surfNormK : Vertex distance correction value
p0 : Coordinate of first vertex right of top of screen.
p1 : Coordinate of second vertex right of top of screen.
p2 : Coordinate of third vertex to right of top of screen.
Output Normal : Normal screen vecter (uint vecter)
Function Value None
Function Calculates normally for the indicated right hand vertex on the screen. The direction in relation to the normal vector is the opposite of right twist. The normal vertor calculation is based on the difference between 2 of 3 vertexes on the screen and finding the relationship.
The correction value of the indicated vertex interval is converted to absolute values to find the maternal relationship based on the 2 vectors. This is because if the 3 pointers on the screen are too small or too large, the 32 bit fixed decimal calculation either underflows or overflows, making a correct calculation difficult. To avoid this, the correction value is used to make sure the absolute value is around 1.0 when the difference of the 23 screen points vector is found. If the vertex interval correction flag is negative, the normal vector will be in the opposite direction.

(There is no page 106 in the original Japanese document.)



DSP I/F Library

1.0 Guide

1.1 Objective

The purpose of this library is to provide an interface for DSP program control.

1.2 Overview

This library has the following interfaces prepared.

· Program load
· Data write
· Data read
· Start program execution
· Stop program execution
· Check for execution end

An overview of each function is provided below.

1.3 Function Overview

- Program load
  Transfers the DSP program stored in work RAM, etc., to DSP program RAM.

- Data write
  Transfers the DSP program data (parameters) stored in work RAM, etc., to DSP data RAM.

- Data read
  Reads DSP data and RAM data (results, etc.)

- Start program execution
  Sets the program counter and starts the DSP program execution.

- Stop program execution
  Stops execution of the DSP program.

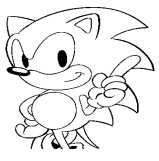
- Check for execution end
  Checks to see if the DSP program has stopped executing.

1.4 Calling Sequence

The calling sequence from program load until results appearing is shown below.

```
void GoDsp ()
 {
      Uint32 dsp_result[10]; /* DSP result storage variable */

      DSP_WriteData(DSP_RAM_1 | 0, (Uint32 *)0x6050000, 15);
      /* Transfer 15 times of data to DSP data RAM, RAM1 from work RAM     */
      DSP_LoadProgram(0, (Uint32 *)0x6050100, 256);
      /* Transfer 256 times of data to DSP program RAM from work RAM       */
      DSP_Start(0);          /* Execute DSP program from 0x00    */
      while(DSP_CheckEnd(&dsp_status) == DSP_NOT_END); /* Loop
                                                          until ends  */
      DSP_ReadData(dsp_result, DSP_RAM_2 | 0, 10);
      /*  Transfer 10 times of data from DSP data RAM, RAM2 to DSP result storage variable */
   ......
 }
```

2.0 Reference

2.1 List of Functions

Function	Function Name	Number
Program load	**DSP_LoadProgram**	1
Data write	**DSP_WriteData**	2
Data read	**DSP_ReadData**	3
Start program execution	**DSP_Start**	4
Stop program execution	**DSP_Stop**	5
Check for execution end	**DSP_CheckEnd**	6

2.2 Function Specifications

Title	Function	Function Name	No
Function Specification	Program load	DSP_LoadProgram	1

Format `void DSP_LoadProgram(Uint8 dst, Uint32 *src, Uint16 count)`
Input dst : DSP program RAM address
src : DSP program storage lead address
count : Transfer repetitions (long word units)
Output None
Function Value None
Function Transfers from the indicated DSP program storage lead address data equal to the number of repetitions specified (long word units) to the DSP program RAM address.

Title	Function	Function Name	No
Function Specification	Data write	DSP_WriteData	2

Format `void DSP_WriteData(Uint8 dst, Uint32 *src, Uint16 count)`
Input dst : DSP data RAM address
src : DSP data storage lead address
count : Transfer repetitions (long word units)
Output None
Function Value None
Function Transfers from the indicated DSP data storage address data equal to the number of repetitions specified (long word units) to the address in the DSP data RAM. Designates the DSP data RAM address, including the selector flag in 8bit.
DSP_RAM_0
DSP_RAM_1
DSP_RAM_2
DSP_RAM_3
DSP_RAM_2 | 3 = Relative third long word RAM2 page.

Title	Function	Function Name	No
Function Specification	Data read	DSP_ReadData	3

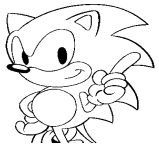
Format `void DSP_ReadData(Uint32 *dst, Uint8 src, Uint16 count)`
Input dst : DSP data storage lead address
src : DSP data RAM address
count : Transfer repetitions (long word units)
Output None
Function Value None
Function Transfers from the indicated DSP data RAM, data equal to the number of repetitions specified (long word units) to the DSP data storage address. Designates the DSP data RAM address, including the selector flag in 8bit.

Title	Function	Function Name	No
Function Specification	Start program execution	DSP_Start	4

Format `void DSP_Start(Uint8 pc)`
Input pc : Program counter
Output None
Function Value None
Function Executes the DSP program from the indicated program counter.

Title	Function	Function Name	No
Function Specification	Stop program execution	DSP_Stop	5

Format `void DSP_Stop(void)`
Input None
Output None
Function Value None
Function Stops the DSP program currently running.



Title	Function	Function Name	No
Function Specification	Check for execution end	DSP_CheckEnd	6

Format Uint8 DSP_CheckEnd(void)
Input None
Output None
Function Value End flag
Constant Name

Constant Name	Explanation
DSP_END	Finished executing
DSP_NOT_END	Executing

Function Checks to see if the DSP program has finished running or not.

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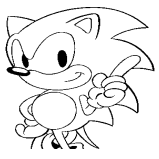

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