TMS320 DSP
DESIGNER'S NOTEBOOK

Bootloading a TMS320C4x Network - Part 1: Direct Connect System

APPLICATION BRIEF: SPRA247

Gerald Capwell
Digital Signal Processing Products
Semiconductor Group

Texas Instruments
July 1994

TEXAS INSTRUMENTS

IMPORTANT NOTICE

Texas Instruments (TI) reserves the right to make changes to its products or to discontinue any semiconductor product or service without notice, and advises its customers to obtain the latest version of relevant information to verify, before placing orders, that the information being relied on is current.

TI warrants performance of its semiconductor products and related software to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Certain application using semiconductor products may involve potential risks of death, personal injury, or severe property or environmental damage ("Critical Applications").

TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS.

Inclusion of TI products in such applications is understood to be fully at the risk of the customer. Use of TI products in such applications requires the written approval of an appropriate TI officer. Questions concerning potential risk applications should be directed to TI through a local SC sales office.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards should be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein. Nor does TI warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used.

TRADEMARKS

TI is a trademark of Texas Instruments Incorporated.

Other brands and names are the property of their respective owners.

CONTACT INFORMATION

US TMS320 HOTLINE	(281) 274-2320
US TMS320 FAX	(281) 274-2324
US TMS320 BBS	(281) 274-2323
US TMS320 email	dsph@ti.com

Contents

Figures

Examples

Bootloading a TMS320C4x Network - Part 1: Direct Connect System

Abstract

This document discusses how to perform an automatic system boot-up at hardware reset, when the TMS320C4x devices are directly connected to each other. A block diagram and several code examples are provided.

Design Problem

If the TMS320C4x devices are directly connected to each other, how can you perform an automatic system boot-up at hardware reset?

Solution

In this case the system is called a “Known, Direct Connect” network. In order to configure a network in this format, the network must have the following criteria:

- The system has one dedicated device known as the system “Parent.” The parent device is configured in hardware via the IIOFx pins to boot from external memory (see section 13.2 of the TMS320C4x User’s Guide) or from a PC platform. The RESETLOC(1,0) pins must be low in order for the on-chip ROM boot loader to load programs from external memory.
- All devices (except the system parent) are called system “Children.” The system child is dependent upon the parent for boot loading. The system children are configured in hardware via the IIOFx pins to boot from communication ports (see section 13-2 of the TMS320C4x User’s Guide).
- The system parent knows where (which communication ports) the children are connected.
- Each parent and child connection is direct. There are no intermediate devices involved in order for the parent to boot load the child.

Figure 1. Known, Direct Connect Network

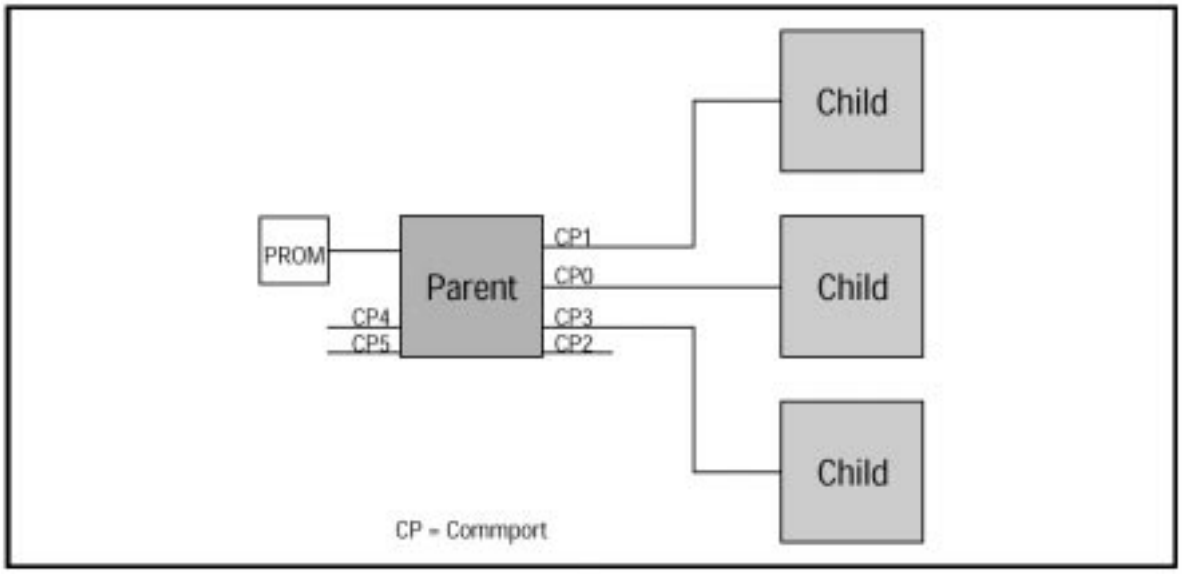


Figure 1 shows the system parent directly connected to the children. At a system reset the parent boot loads from external memory (PROM) and begins performing its tasks as the system parent. Each child polls its communication ports (function of the on-chip ROM boot loader) to see if the parent is attempting a boot. The parent knows where (which communication port) the child is connected. The example C code below demonstrates the process the parent follows in order to boot load the network. Pointers are initialized at the beginning and end of the boot table. The pointer at the beginning of the boot table is incremented after each word is transmitted to the child (out_word command) and continues until the end of the boot table is reached. At this point the child is booted and the parent repeats for all system children.

Example 1. System parent

```
int port_addr = 100040h;
                  /* init port pointer to comm port 0 */
extern int beg_label, end_label;
                  /* init external labels of the boot table */
int port [6] = {1, 2, -1, 3, -1, -1};
                  /*init CP connection matrix. -1's indicate no connect*/
volatile int *table_ptr, *end_ptr;
                  /* init the boot table pointer and end table pointer */
end_ptr = &end_label;
                  /* set end pointer to the end of boot table */
main
{
for (CPX = 0; CPX 6; CPX++)
                  /* Continue for all six comm ports */
    {
        if (port [CPX] = 0)
                  /* If child is connected then boot (!= -1) */

            table_ptr = &beg_label;
                  /* Set table ptr to the beginning of boot table */
port_addr = port_addr +(10h*CPX);
                  /* Point to next comm port address */
    do
    {
        *(port_addr + 2) = *table_ptr;
                  /* Copy data at table_ptr to cp out mem. loc */
        table_ptr++;    /* Increment ptr to next word of boot table */
    }while(table_ptr end_ptr);
                  /* Continue until complete boot table is */
        }         /* transmitted through CPX. */
CPX++;            /* Next comm port */
    }
}
```

When the first data word is sent from the parent, the child locks onto the communication port, stores the communication port address to register AR3, and continues to receive data until the termination word is received. If the child does not receive the complete boot table in the correct format, the child will never completely boot-up. Please refer to section 13-2 of the TMS320C4x User's Guide to learn more about the boot table requirements.

The parent code in Example 1 uses external labels to reference the boot table. The external labels are resolved when the boot table is linked to the parent's application code. The code that resides in the parent is shown in Example 3.

To create the boot table and link it to the parent's application, there are several steps that must be taken to convert the child's application code. The steps are listed below:

- The child application should remain self contained, assembled, and linked as an independent application (`child.out`).

- Use the Hex30 Conversion Utility to convert the `.out` file to a PROM programming file in boot table format. Please read the Hex30 Utility Addendum (Literature number SPRU081) to learn more about creating a boot table (-boot command) using Hex30. An example Hex30 command file is shown in Example 2:

Example 2. Hex30 Command File

```
child.out        /* Specify input COFF file */
-o child.hex     /* Specify output filename */
-a               /* Convert file to Hex30 ASCII format */
-memwidth 32     /* Word length of device (32 bits wide) */
-romwidth 32     /* Specify 32 to convert the complete word */
-boot            /* Hex30 to construct boot table header */
   :               :               :
   :               :               :
```

- • Now use the HEX2ASM conversion utility (executables and directions available on TMS320 BBS in archived file called hex2asm.exe) to convert the Hex30 programmer file (`child.hex`) to an assembly file (`child.asm`). The HEX2ASM utility extracts the valuable data and creates `.word` xxxxxh for each 32-bit word and saves it in a `.sect` table. The HEX2ASM converter can also include global labels. In Figure 2, the global labels that the parent references are beg_label and end_label.

NOTE:

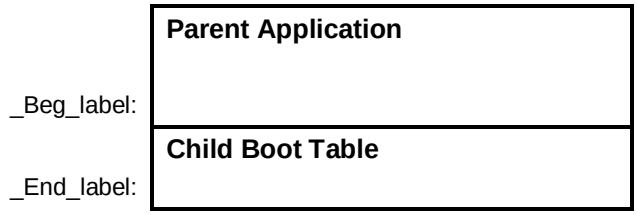
Also please note that labels can be defined in the final linker `.cmd` file when linking the child boot table to the parent application code. This is accomplished by including the following in the linker `.cmd` file.

Example 3. Defining labels in the linker command file

```
SECTIONS
{
.child:          {_beg_label = .;
                 *(.child)
                 _end_label = . -1; } RAM 1
```

- • The output of the HEX2ASM converter is an assembly file. Link the child`.obj` file with the parent's parent`.obj` file.

Figure 2. Parent's Memory Map



At this point the parent application is linked to the child application (in boot table format) as illustrated in Figure 2. At reset, the parent device must boot load this information from external memory or a PC platform. If the parent boots from external memory the final (parent + child) code must be converted again by the Hex30 utility to create the PROM programmer file. If booting the parent via a PC platform, the data must be converted again in order for the PC to read and transmit the boot information properly.