

*TMS320 DSP  
DESIGNER'S NOTEBOOK*

# ***Circular Buffer in Second Generation DSPs***

---

---

---

*APPLICATION BRIEF: SPRA203*

*Contributed by Randy Restle  
Digital Signal Processing Products  
Semiconductor Group*

*Texas Instruments  
December 1992*



## **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

Abstract.....	7
Design Problem .....	8
Solution .....	8

## Figures

Figure 1. Data order for bit-reversed circular buffer .....	9
---	---

# Circular Buffer in Second Generation DSPs



## Abstract

Third and fourth generation DSPs (TMS320C3x/4x) include a circular buffer addressing mode. The second generation DSPs (TMS320C2x) do not. The integer TMS320 devices make the use of a circular buffer unnecessary because they can perform data movement simultaneously with arithmetic processing, with no penalty to code size or execution time. This is very efficient because it circumvents the overhead of maintaining a buffer pointer. However, some applications still benefit from circular buffers.

The TMS320C25 can manipulate circular buffer pointers without penalty to code size or execution time. This document discusses how to implement this, and describes how this techniques works for a TMS320C25.



---

## Design Problem

Third and fourth generation DSPs (TMS320C3x/4x) include a circular buffer addressing mode. The second generation DSPs (TMS320C2x) do not. The integer TMS320 devices make the use of a circular buffer unnecessary because they can perform data movement simultaneously with arithmetic processing, with no penalty to code size or execution time. This is very efficient because it circumvents the overhead of maintaining a buffer pointer. However, some applications still benefit from circular buffers. An example is a decimation filter because multiple data values must be skipped. In this case, it is usually more efficient to add an offset to a pointer rather than perform multiple data movements.

## Solution

The TMS320C25 can manipulate circular buffer pointers without penalty to code size or execution time. This is done by using its integral bit-reversed addressing capability, normally used in FFT solutions. In this mode, carries from each bit of the addition of AR0 and the current auxiliary register are propagated to the right instead of the left. The carry from the rightmost bit is ignored, effectively performing a modulo N addition, where N is the size of the buffer. N must be restricted to a power of 2.

Figure 1 shows the order in which data values will be stored and their corresponding binary addresses for a buffer of size 8. AR0 must be loaded with the size of the buffer divided by 2, and the coefficients that are to be multiplied by the circular-buffered values must be stored in a corresponding bit-reversed fashion. Traversing the data in bit-reversed order does operate on every data point - just not in linear order. For buffers where order is not important, but efficiency is important, this method works well.

Figure 1. Data order for bit-reversed circular buffer

