THIS APPLICATION CAN BE DONE USING:

PRODUCTS
- Block Diagram
- RIDE
- ImageDSP
- VIDSP Studio
- VIDSP Suite
- OORVL Design Studio

Deadbeat Controller

Overview

Control systems are a necessary part of modern manufacturing, many industrial processes, and can be found in a variety of products that affect our daily lives. They range from simple controls like those found on an air conditioner to more complex controls like those found in a missile guidance system. This application note will discuss the implementation of a Deadbeat Controller in the Hypersignal Block Diagram and RIDE graphical design environments.

A desired characteristic in a control system design is an achieved quick settling time. A deadbeat controller is often used when a quick or finite settling time is required. A deadbeat controller reaches a steady state in N+1 samples, where N is the order of the controller. Deadbeat controllers compensate for the poles of the system, and should therefore not be applied to systems with poles outside (or in the vicinity of) the unit circle. Deadbeat controllers should only be used with stable plants or processes. Otherwise they may cause instability.

This application note describes how Hypersignal Block Diagram or Hypersignal RIDE can be used to quickly develop and implement a Deadbeat control system design. Using this graphical approach to implementing a control systems algorithm provides a dramatic improvement over traditional design methods, and yields many benefits such as increased productivity, greater design flexibility, and vastly reduced design schedules.

Product Specific Information

Hypersignal Block Diagram is a complete visual design environment that allows design algorithms to be created out of individual block components and data flow line connections. Hypersignal RIDE is a superset of Hyperception's Block Diagram product, and as such, contains all of its simulation capabilities and functionality. However, RIDE additionally provides the capability of creating real-time DSP applications by simply connecting block function icons together with a mouse. RIDE provides full-featured COFF support, heterogeneous multiple processor support, full target DSP memory map control, interrupt hooking, DSP memory operations, symbol table, code profiling capability, multi-rate support, virtual DSP support, complete system statistics, and complete real-time DSP application export. Hypersignal RIDE also includes an extensive real-time and simulation block function library. Custom block functions are easily added through use of the included Block Wizard utility.

Detailed Description

This application note will demonstrate how Hypersignal Block Diagram and RIDE software can be used to implement a Deadbeat Controller.

A deadbeat control system contains a reference input signal, the digital deadbeat controller, the plant /motor, a feedback path, and an output signal. This example will use a square wave generator as the input signal. The Deadbeat controller is implemented by a hierarchy block component and the DC Servo motor/plant model is also implemented with a hierarchy block component.

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The deadbeat control systems design algorithm is shown in Figure 1, below.

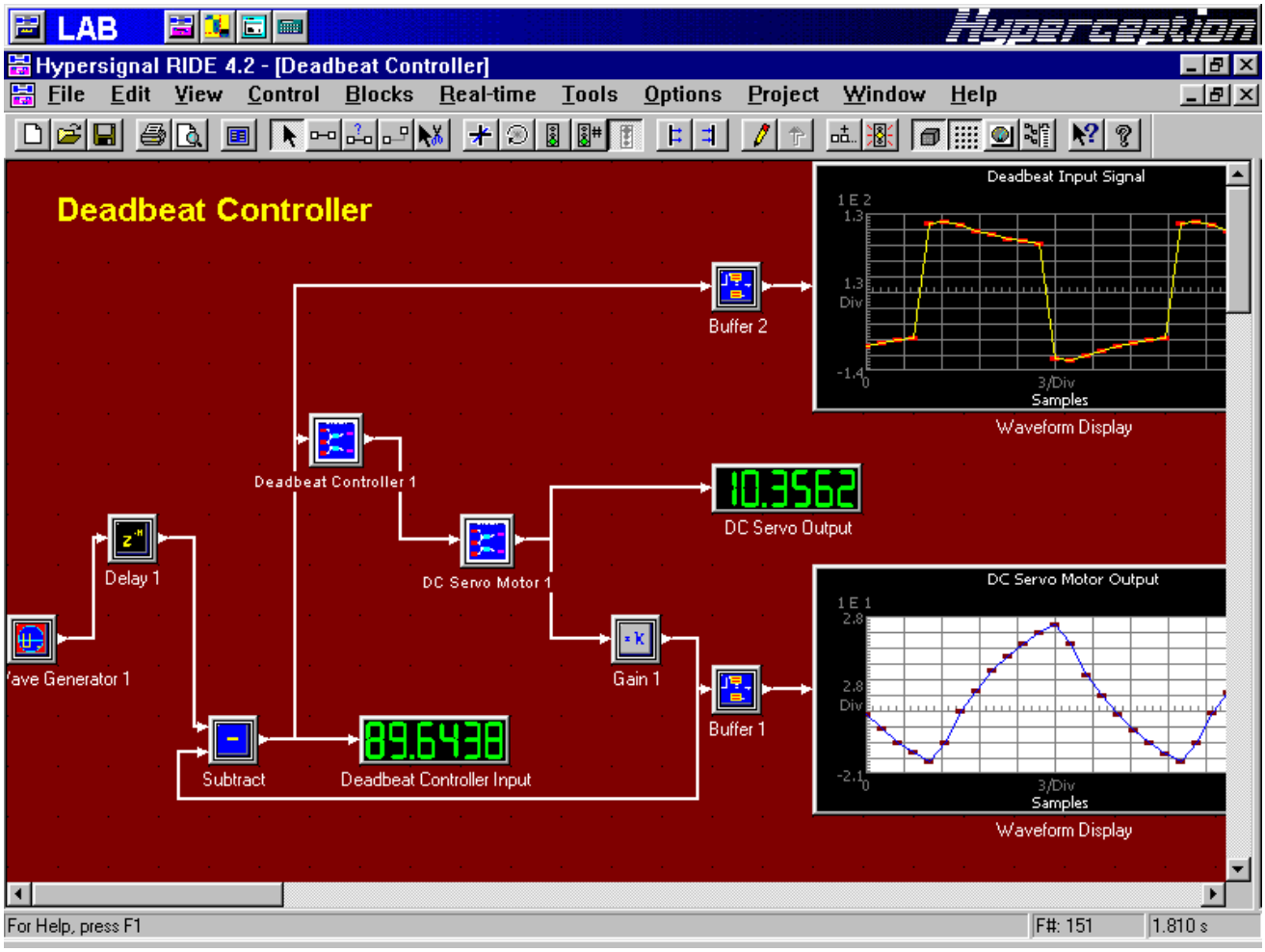

Figure 1. Implementation of a Deadbeat Controller

Implementation

DC Servo Motor Model

A deadbeat controller obtains its transfer function coefficients from the parameters of the motor/plant to be controlled. In this example we are using a model of a DC servo motor that has the transfer function as shown in Figure 2, below:

$$Gm(z) = \frac{(0.269z^{-1} + 0.269z^{-2})}{(1.0 - 1.999z^{-1} + 0.999z^{-2})}$$

Figure 2 – DC Servo Motor Model Transfer Function

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In the Hypersignal design worksheet the DC Servo Motor is implemented with a hierarchy block component. When this block component is expanded into its underlying block functions it can be seen that the motor transfer function is actually implemented with a low-level biquad structure that has been constructed with delay lines, gain stages, and feedback paths. The DC Servo Motor hierarchy block used in this example is shown in Figure 3, below.

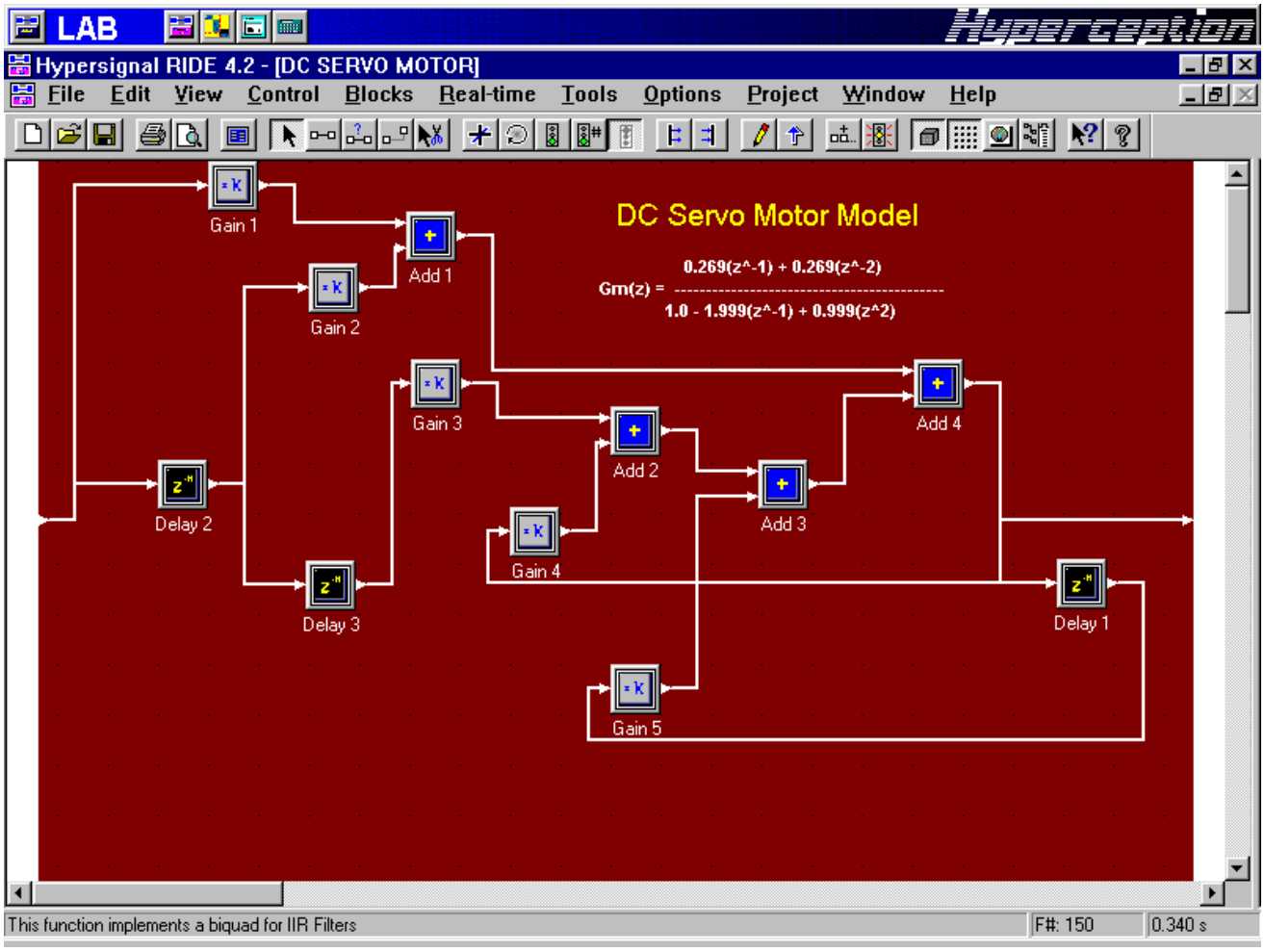

Figure 3– DC Servo Motor Implementation

Deadbeat Controller Model

The order N of the deadbeat controller transfer function is the same as the order of the motor/plant transfer function. To design the deadbeat controller its coefficients have to be found from the parameters of the motor/plant to be controlled.

Given that the motor/plant transfer function in this example is a second-order system, the deadbeat controller is also a second-order system. For this example, the deadbeat controller transfer function works out to be as

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listed in Figure 4, below.

$$Gdb(z) = \frac{(0.1566 - 0.3129z^{-1} + 0.1564z^{-2})}{(1.0 - 0.4218z^{-1} - 0.4216z^{-2})}$$

Figure 4 – Deadbeat Controller Transfer Function

As with the DC Servo Motor model, the Deadbeat Controller is also implemented with a hierarchy block component. When this block is opened-up into its sub-level components it can be seen that the second-order transfer function of the controller has been implemented with a low-level biquad structure that has been constructed with delay lines, gain stages, and feedback paths. The Deadbeat Controller hierarchy block used in this worksheet is shown in Figure 5, below.

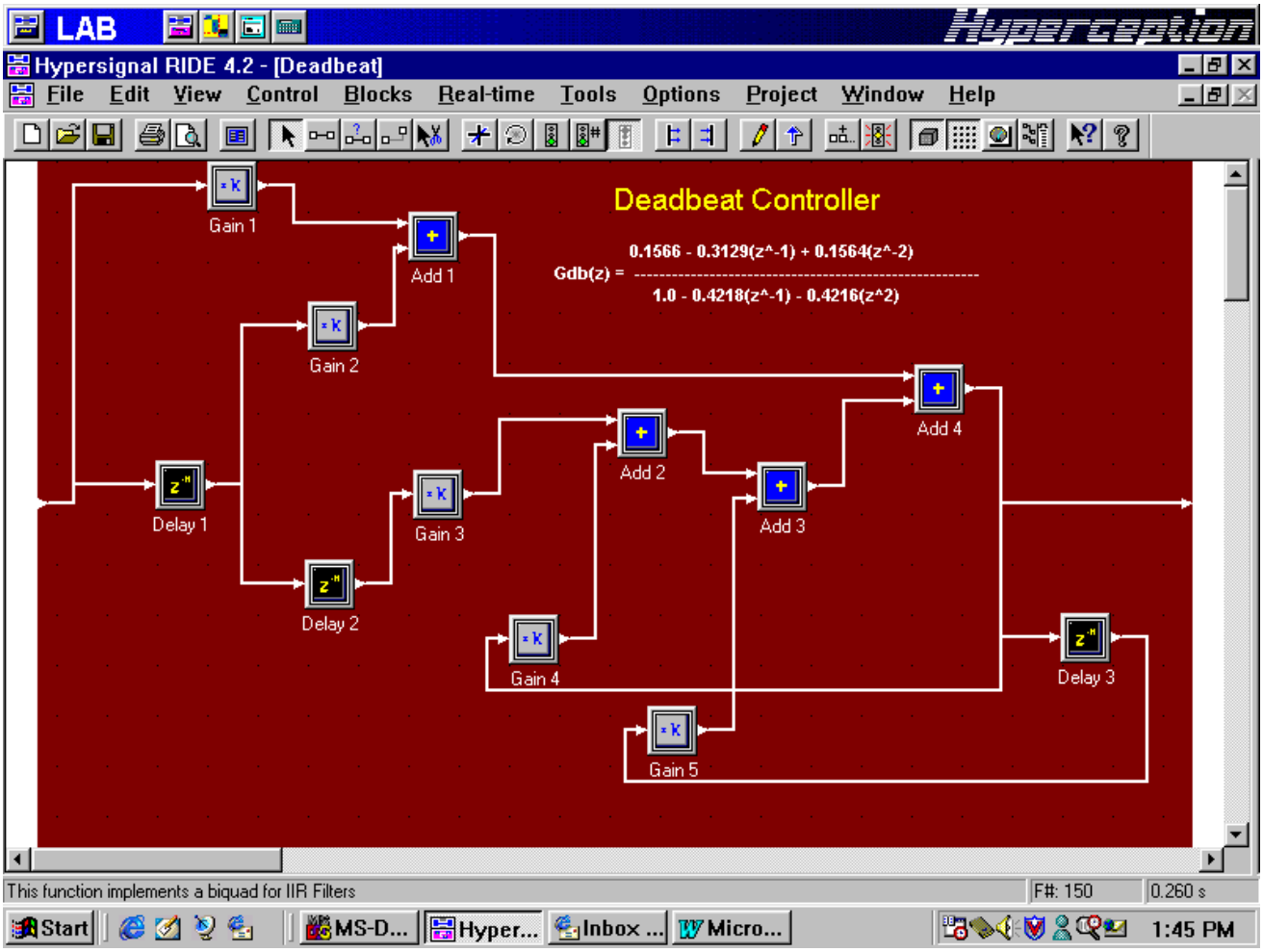

Figure 5– Deadbeat Controller Implementation

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Applications

The implementation of a Deadbeat controller design is quickly achieved with Hypersignal Block Diagram or RIDE software. By simply creating a block diagram representation of the desired algorithm via block function icons and line connections the user can efficiently create and test the control systems algorithm. The entire design has been conducted in the Hypersignal graphical design environment without the need for writing and debugging time-consuming code that is required by traditional methods.

References

Irfan Ahmed, "*Implementation of PID and Deadbeat Controllers with the TMS320 Family*", from Digital Signal Processing Applications with the TMS320 Family - Theory, Algorithms, and Implementations; Volume 2, p. 529, 1990.

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