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VisSim Embedded

Model-Based Design of Embedded Systems

Key Highlights

- Intuitive graphical interface for model-based design and simulation of embedded systems
- Rapid prototyping and code generation for Texas Instruments MCUS
- Automatic programming of on-chip peripherals
- Production-quality C code with automatic scaling of fixed-point operations
- Algorithm validation using off-line simulation
- Automatic compilation, linking, and download of algorithm to the target
- JTAG hotlink for target-in-the-loop verification
- Retain the VisSim GUI while the algorithm executes on the target

System Requirements

- Windows XP, Vista, 7, or 8
- 1 GB RAM
- Texas Instruments CCS v3+
- Target hardware
- JTAG emulator (TI, Spect. Digital, Blackhawk, or compatible)
- Texas Instruments CCS v3+

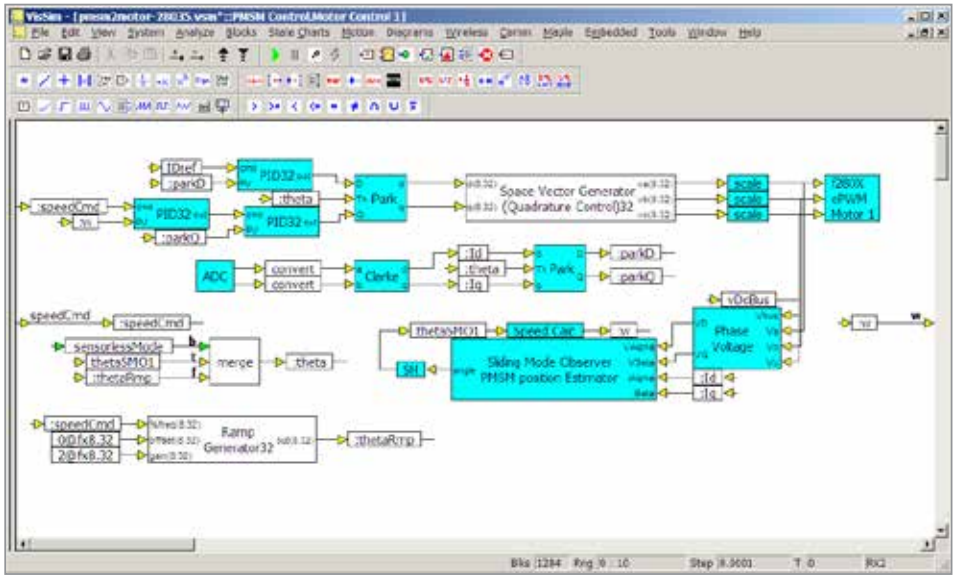
Introduction

VisSim Embedded is a graphical environment for model-based embedded development The generated code is both highly-optimized and compact, which is essential for low-cost microprocessors and high-speed sampling rates.

By performing off-line simulation and prototyping, you can identify and correct problems in the control algorithms earlier in the design cycle, resulting in lower development costs and faster time to market.

VisSim Embedded has deep support for Texas Instruments C2000 and MSP430 control MCUs. It covers hundreds of part configurations, consisting of different peripheral mixes, Flash, and RAM, making it easy to choose the part best suited for your design.

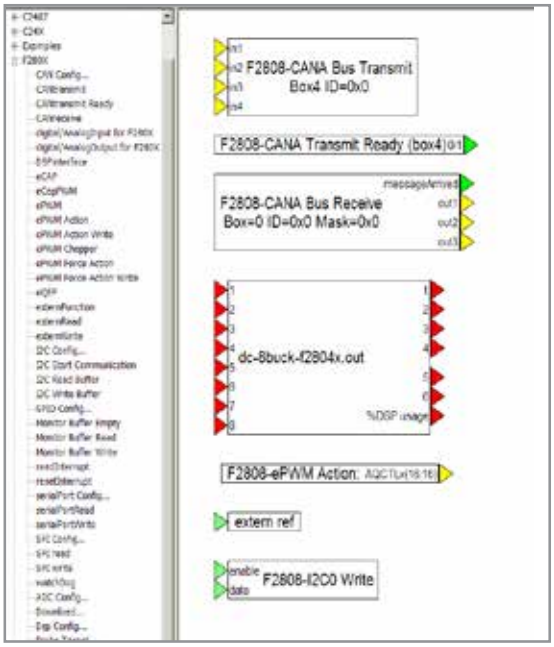
Model-Based Design



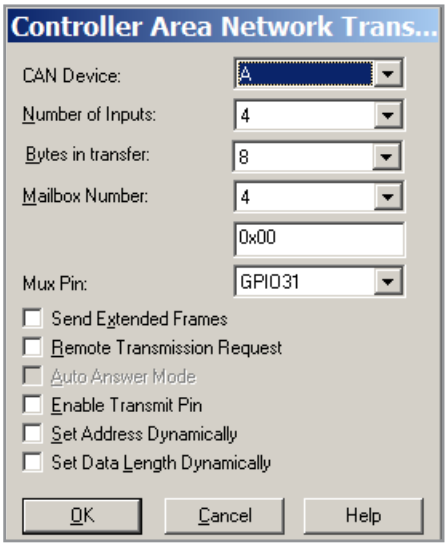
Subsystem 1 of two sensorless PMSM motors using sliding mode observer estimation of rotor position. Sample rate is 10 kHz running both motors on a Piccolo F28036 with 50% utilization.

When I used C code to develop and debug my digital control algorithms, it was like I was fumbling around a twisty maze with high walls. When I switched to VisSim, I got a bird's eye view of that maze and a clear view of the path to solution. I will never go back to C coding for my digital power and digital control applications.

Anthony Boon, Chief Engineer, ETA Electronic Design



The Block Browser lists all C2000, MSP430, and target-specific blocks in a collapsible tree. To add a block to your diagram just slide it off the Browser and into the workspace.



Right-click over a block to access customizable parameters and options.

Using VisSim Embedded, you can build a model of your entire system, including the control algorithm and the plant.

The controller system can be built in scaled, fixed-point arithmetic, while the plant is built in full-precision, floating point arithmetic.

For model construction, VisSim Embedded provides extensive block libraries, including:

- TI C2000 Motor Control block library
- TI InstaSPIN block library
- On-chip peripheral block library
- Fixed-point block librarly
- Motor block library (available separately)

TI C2000 Motor Control Blocks

The TI C2000 Digital Motor Control blocks are used to design motion control systems based on AC induction, brushless DC, PMSM, and stepper motors.

VisSim Embedded provides both 16- and 32-bit digital motor control blocks, including PID, 3-Phase PWM Drivers, Space Vector Waveform Generators, Park and Clarke Transforms, Volts-to-Hertz Profiles, sensorless flux and rotor speed estimation, and quadrature-encoder-based speed calculator.

Sample diagrams are included with VisSim Embedded for sensored and sensorless vector control of PMSM and AC induction motors.

TI InstaSPIN Blocks

The InstaSPIN block library allows sensorless rotor position estimation using algorithms burned into ROM on selected chips.
The InstaSPIN blocks perform identification of key motor parameters, as well as field-oriented motor control. The blocks also provide a simple interface to the complex InstaSPIN API, thereby shortening your design time for InstaSPIN applications.

Target-Specific Blocks

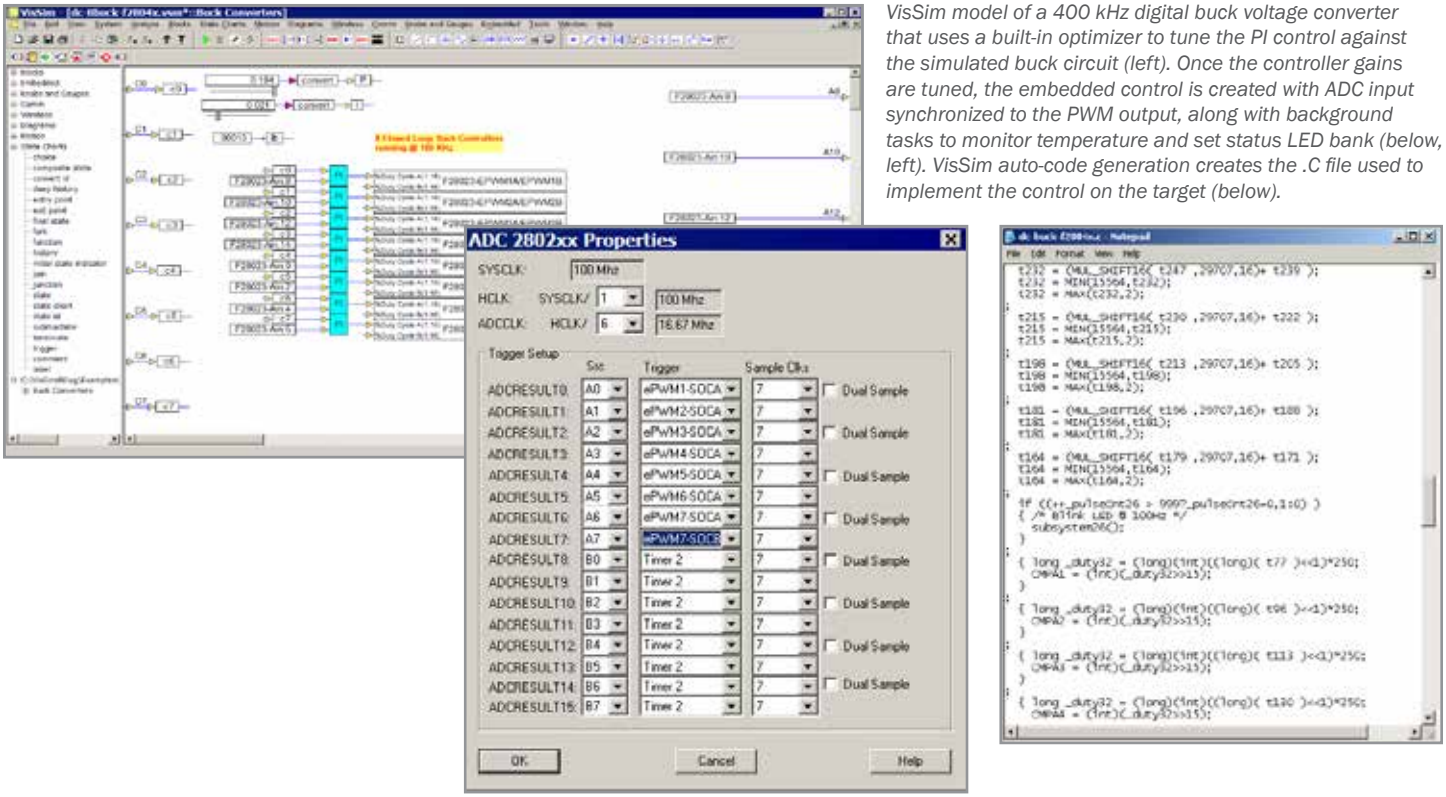
The target-specific blocks let you easily program on-chip devices. Using built-in These blocks include analog ADC, ePWM, eCAP (event capture), SPI, SCI (RS232 serial), I2C, digital GPIO, QEP(quadrature encoder), and CAN 2.0.

CAN Bus Support: CAN bus blocks offer an extensive range of capabilities to support the development of systems with CAN communication. The CAN transmit and receive blocks support up to 32 CAN mailboxes on the TI C2000 series. Baud rates to 2 megabits are supported. Mailboxes are configurable from 0- to 8-byte data packet size. User-configurable addressing can be 11 or 23 bits. Remote frame requests and auto-answer are also supported.

Serial LCD: Serial LCD blocks support up to 4-line-by-20-column serial interfaced LCDs. You can compose text prompts, numeric formatting, field placement, and page address for each block. Additionally, runtime paging commands are supported. Serial baud rate, serial protocol, and LCD vendor format are user-configurable.

Scaled, Fixed-Point Algorithms

The Fixed-Point blockset lets you perform simulation and efficient code generation of scaled, fixed-point operations.



VisSim model of a 400 kHz digital buck voltage converter that uses a built-in optimizer to tune the PI control against the simulated buck circuit (left). Once the controller gains are tuned, the embedded control is created with ADC input synchronized to the PWM output, along with background tasks to monitor temperature and set status LED bank (below, left). VisSim auto-code generation creates the .C file used to implement the control on the target (below).

Overflow and precision loss effects are easily seen and corrected at simulation time. Auto-scaling speeds fixed-point development, while in-line code generation creates fast target code.

Off-line Simulation

During initial simulation of the controller and plant, you can verify, debug, and tune your control algorithms, and view the results interactively in graphical plots. This step lets you interact with and assess the simulated controller and the simulated plant.

Automatic Code Generation

Once the model is verified, you can automatically generate code for the controller and download the code to the target MCU. The code is optimized for speed and memory usage.

You can execute the generated code with your plant model within VisSim to verify successful translation of model to code.

Efficient ANSI C Code

VisSim Embedded generates efficient and compact ANSI C code for discrete, continuous, and hybrid systems. MCU target support includes a report to display the COFF section sizes of the generated execution file.

For example, code generated for closed-loop motor control - including, PI controller, digital output, PWM, and encoder peripherals - runs at 300KHz on a 150MHz F28335 MCU.

The memory footprint is:
Code size: 2095 bytes
Initialized data: 501 bytes
Uninitialized data: 504 bytes

MCU-in-the-Loop Simulation

In MCU-in-the-loop simulation, the plant model runs on the host computer in VisSim while the control algorithm runs in real time on the target MCU. Real-time communication between the target MCU and VisSim is performed via a JTAG hotlink. The VisSim GUI is retained while you tune parameters and monitor real-time data.

Synchronous MCU-in-the-Loop Simulation

VisSim Embedded also supports a PIL-synchronous communication mode that runs the target in lock step with the simulation, allowing easy verification of embedded algorithms.

Unsupported Platforms

You can extend VisSim Embedded to target unsupported platforms using the VisSim Support Library Source Code (available separately). The generated fixed-point and floating-point code can be compiled on any platform with an ANSI C compiler.

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VisSim Blocks

Summary of Standard

Animation
animate
animation3D
camera3D
light3D
lineDraw
mesh3D
world3D

Annotation
bezel
comment
date
index
label
scalarToStruct
scalarToVec
StructToScalar
variable
vecToScalar
wirePositioner

Arithmetic
-X
*
/
abs
complexToReIm
convert
gain
magPhase
pow
sign
summingJunction
unitConversion

Audio
audioIn
audioOut

Boolean
>
<
>=
<=
==
!=
and
not
or
xor

DDE
DDE
DDEreceive
DDEsend

Integration
integrator
limitedIntegrator
resetIntegrator

Linear Systems
stateSpace
transferFunction

MatLab Interface
MatLab Expression
MatLab Read Variable
MatLab Write Variable

Matrix Operations
buffer
diag
dotProduct
eigenvalues
fft
ifft
indexAssigned
invert
linearSolve
maxElement
minElement
matrixConst
matrixIn
matrixMerge
matrixOut
matrixSize
meanSmooth
medianSmooth
multiply
polyFit
polyRoots
psd
reshape
splineFit
transpose
vectorSort
vsum

Nonlinear
case
crossDetect
deadband
delayedSwitch
init
limit
map
max
merge
min
quantize
relay
sampleHold

Optimization
constraint
cost
globalConstraint
parameterUnknown
unknown

Random Generator
beta
cauchy
erlang
gamma
gaussian
pareto
PRBS
rayleigh
triangular
uniform
weibull

Real-Time
rt-DataIn
rt-DataOut
ActiveXread
ActiveXwrite

State Chart
statechart
trigger

State Transition
stateTransition

Signal Consumer
display
error
execOrder
eventDisplay
eventLog
export
histogram
light
meter
plot
polarPlot
plot3D
spectrumDisplay
stop
stripChart
video

Signal Producer
button
Const
dialogConstant
dialogTable
import
parabola
pulseTrain
ramp
realTime
sawtooth
sinusoid
slider
squareWave
step
timeStamp
triangleWave

Time Delay
timeDelay
unitDelay

Transcendental
acos
asin
atan2
bessel
cos
cosh
exp
ln
log10
sin
sinh
sqrt
tan
tanh
Embedded Blocks

General
embed*
expression
OLEobject
userFunction*

Bold blocks indicate new version 9 blocks and new features to existing blocks

Blocks followed by an asterisk (*) are not included in the Personal or Student Edition of VisSim

Embedded Blocks

Summary of Blocks

Fixed Point Blocks

abs
and
atan2
const
convert
cos
CRC 16
div
gain
limit
limitedIntegrator
merge
mu
not
or
PI Regulator
PID Regulator
sampleHold
shift
sign
sin
sqrt
sum
transferFunction
unitDelay
xor
-X
>
<
<=
>=
==
!=

Target-Specific Blocks

ADC10/12
AIO In
AIO Out
Analog Comparator DAC
Analog In
Analog Input
Analog Output
CAN Receive
CAN Transmit
CAN Transmit Ready
Comparator
Comparator DAC
DAC
DAC12
Digital/Analog Input
Digital Input
Digital Output
DMA Enable
Download
eCAP
eCAP PWM
ePWM
ePWM Action
ePWM Action Write
ePWM Chopper
ePWM Force Action
ePWM Force Action Write
eQEP
Event Capture
Extern Definition
Extern Function
Extern Read
Extern Write
Full Compare Action
Full Compare PWM
Get CPU Usage
Get Target Stack and Heap
GPIO In
GPIO Out
I2C Read Buffer
I2C Start Communication
I2C Write Buffer
I/O Memory Read
I/O Memory Write
LCD
LCD Control
Monitor Buffer Empty
Monitor Buffer Read
Monitor Buffer Write
Op Amp
PWM
Quadrature Encoder
Read Target Memory
Reset Target
SD16
SD16A
Segment LCD
Serial UART Read
Serial UART Write
SPI Read
SPI Write
Target Interface
Watchdog
Web Server

Digital Motor Control Blocks

ACI Flux Estimator
ACI Motor
ACI Speed Estimator
Clarke Transform
Current Model
Inverse Clarke Transform
Inverse Park Transform
Park Transform
Phase Voltage Calc
PID Regulator
QEP Speed
Ramp Generator
Resolver Decoder
SMO Position Estimator
Space Vector Generator (Mag/Freq)
Space Vector Generator (Quad Control)
Space Vector PWM
Speed Calculator
V/Hz Profile Generator

MotorWare Blocks

Angle Estimator
Controller Read Property
Controller Write Property
Estimator Read Property
Estimator Write Property
Motor Control

Motion Blocks (available separately)

Amplifiers
Controllers
Filters
Loads
Motors
Sensors
Sources
Tools
Transfroms

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