FAN6550

2A DDR Bus Termination Regulator

Features

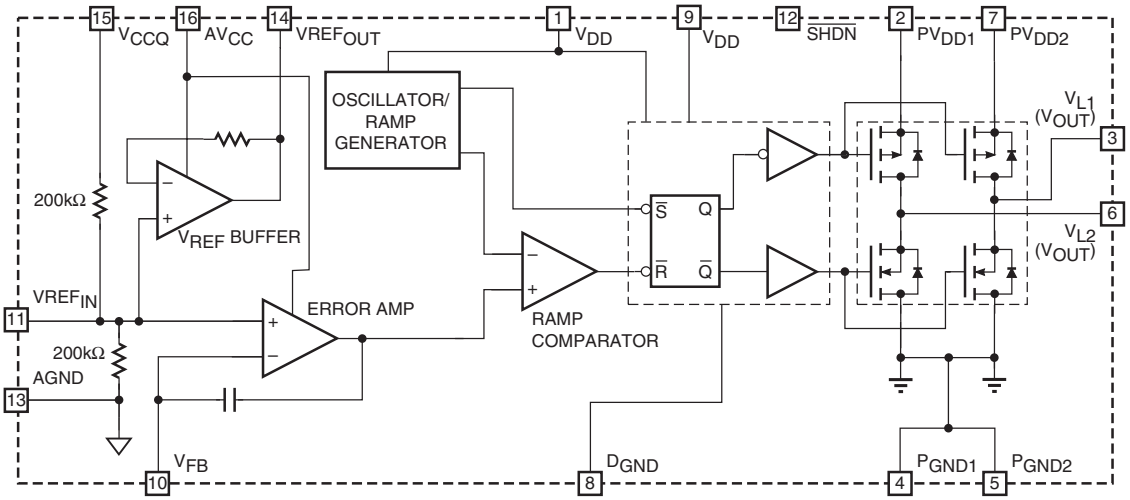
- Can source and sink up to 2A continous, 3A peak
- No heatsink required
- Integrated Power MOSFETs
- Generates termination voltages for DDR SDRAM
- V_{REF} input available for external voltage divider
- Separate voltages for V_{CCQ} and PV_{DD}
- Buffered V_{REF} output
- V_{OUT} of ±3% or less at 2A
- Minimum external components
- 0°C to 70°C operating range
- Shutdown for standby or suspend mode operation
- Thermal Shutdown ≈ 130ºC

Description

The FAN6550 switching regulator is designed to convert voltage supplies ranging from 2.3V to 4V into a desired output voltage or termination voltage for DDR SDRAM memory. The FAN6550 can be implemented to produce regulated output voltages in two different modes. In the default mode, when the V_{REF} pin is open, the FAN6550 output voltage is 50% of the voltage applied to V_{CCQ}. The FAN6550 can also be used to produce various user-defined voltages by forcing a voltage on the $VREF_{IN}$ pin. In this case, the output voltage follows the input $VREF_{IN}$ voltage. The switching regulator is capable of sourcing or sinking up to 2A of current while regulating an output V_{TT} voltage to within 3% or less. Transient output currents of ±3A can also be accommodated.

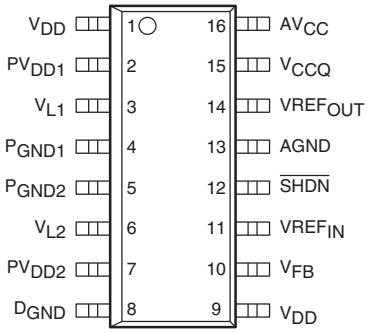
The FAN6550 can also be used in conjunction with series termination resisitors to provide an excellent voltage source for active termination schemes of high speed transmission lines as those seen in high speed memory buses and distributed backplane designs.

Block Diagram



Pin Configuration

FAN6550
16-Pin SOIC (M16)



TOP VIEW

Pin Description

Pin	Name	Function
1	V_{DD}	Digital supply voltage
2	PV_{DD1}	Voltage supply for internal power transistors
3	V_{L1}	Output voltage/ inductor connection
4	P_{GND1}	Ground for output power transistors
5	P_{GND2}	Ground for output power transistors
6	V_{L2}	Output voltage/inductor connection
7	PV_{DD2}	Voltage supply for internal power transistors
8	D_{GND}	Digital ground
9	V_{DD}	Digital supply voltage
10	V_{FB}	Input for external compensation feedback
11	$VREF_{IN}$	Input for external reference voltage
12	$\overline{SHDN}$	Shutdown active low. CMOS input level
13	AGND	Ground for internal reference voltage divider
14	$VREF_{OUT}$	Reference voltage output
15	V_{CCQ}	Voltage reference for internal voltage divider
16	AV_{CC}	Analog voltage supply

Absolute Maximum Ratings

Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

Parameter	Min.	Max.	Units
PV_{DD}		4.5	V
Voltage on Any Other Pin	GND – 0.3	V_{IN} + 0.3	V
Average Switch Current (I_{AVG})		2.0	A
Junction Temperature		150	°C
Storage Temperature Range	-65	150	°C
Lead Temperature (Soldering, 10 sec)		300	°C
Thermal Resistance (θ_{JA})		30	°C/W
Output Current, Source or Sink (peak)		3.0	A

Operating Conditions

Parameter	Min.	Max.	Units
Temperature Range	0	70	°C
PV_{DD} Operating Range	2.0	4.0	V
V_{CCQ} Operating Range	1.4	4.0	V

Electrical Characteristics

Unless otherwise specified, $AV_{CC} = V_{DD} = PV_{DD}$ = 3.3V ±10%, TA = Operating Temperature Range (Note 1)

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Units
Switching Regulator							
V_{TT}	Output Voltage, V_{TT} (See Figure 1)	I_{OUT} = 0, V_{REF} = open Note 2	V_{CCQ} = 2.3V	1.12	1.15	1.18	V
			V_{CCQ} = 2.5V	1.22	1.25	1.28	V
			V_{CCQ} = 2.7V	1.32	1.35	1.38	V
		I_{OUT} = ±2A, V_{REF} = open Note 2	V_{CCQ} = 2.3V	1.09	1.15	1.21	V
			V_{CCQ} = 2.5V	1.19	1.25	1.31	V
			V_{CCQ} = 2.7V	1.28	1.35	1.42	V
$VREF_{OUT}$	Internal Resistor Divider	I_{OUT} = 0 Note 2	V_{CCQ} = 2.3V	1.139	1.15	1.162	V
			V_{CCQ} = 2.5V	1.238	1.25	1.263	V
			V_{CCQ} = 2.7V	1.337	1.35	1.364	V
Z_{IN}	V_{REF} Reference Pin Input Impedance	Note 2	V_{CCQ} = 0		100		kΩ
	Switching Frequency				650		kHz
ΔV_{OFFSET}	Offset Voltage V_{TT} – $VREF_{OUT}$	V_{CCA} = 2.5V No Load	V_{CCQ} = 2.5	–20		20	mV
Supply							
I_Q	Quiescent Current	I_{OUT} = 0, no load V_{CCQ} = 2.5V	I_{VCCQ}		6	10	µA
			I_{AVCC}		0.5	1.0	mA
			I_{AVCC} SD		0.2	0.5	mA
			I_{VDD}		0.25	1.0	mA
			I_{VDD} SD		0.2	1.0	mA
			I_{PVDD}		100	250	µA
Buffer							
I_{REF}	Output Load Current			3			mA

Notes

1. Limits are guaranteed by 100% testing, sampling, or correlation with worst-case test conditions.
2. AV_{CC}, PV_{DD} = 3.3V ±10%

Functional Description

The FAN6550 integrates two power MOSFETs that can be used to source and sink 2A of current while maintaining a tight voltage regulation. Using the external feedback, the output can be regulated well within 3% or less, depending on the external components chosen. Separate voltage supply inputs have been added to accommodate applications with various power supplies for the databus and power buses.

Outputs

The output voltage pins (V_{L1}, V_{L2}) are tied to the databus, address, or clock lines via an external inductor. See the Applications section for recommendations. Output voltage is determined by the V_{CCQ} or $VREF_{IN}$ inputs.

Inputs

The input voltage pins (V_{CCQ} or $VREF_{IN}$) determine the output voltages (V_{L1} or V_{L2}) . In the default mode, where the $VREF_{IN}$ pin is floating, the output voltage is 50% of the V_{CCQ} input. V_{CCQ} can be the reference voltage for the databus.

Output voltage can also be selected by forcing a voltage at the $VREF_{IN}$ pin. In this case, the output voltage follows the voltage at the $VREF_{IN}$ input. Simple voltage dividers can be used this case to produce a wide variety of output voltages between 2.3V to 4V.

VREF Input and Output

The $VREF_{IN}$ input can be used to force a voltage at the outputs (Inputs section, above). The $VREF_{OUT}$ pin is an output pin that is driven by a small output buffer to provide the V_{REF} signal to other devices in the system. The output buffer is capable of driving several output loads. The output buffer can handle 3mA.

Other Supply Voltages

Several inputs are provide for the supply voltages: PV_{DD1}, PV_{DD2}, AV_{CC}, and V_{DD}.

The PV_{DD1} and PV_{DD2} provide the power supply to the power MOSFETs. V_{DD} provides the voltage supply to the digital sections, while AV_{CC} supplies the voltage for the analog sections. Again, see the Applications section for recommendations.

Feedback Input

The V_{FB} pin is an input that can be used for closed loop compensation. This input is derived from the voltage output. See application section for recommendation.

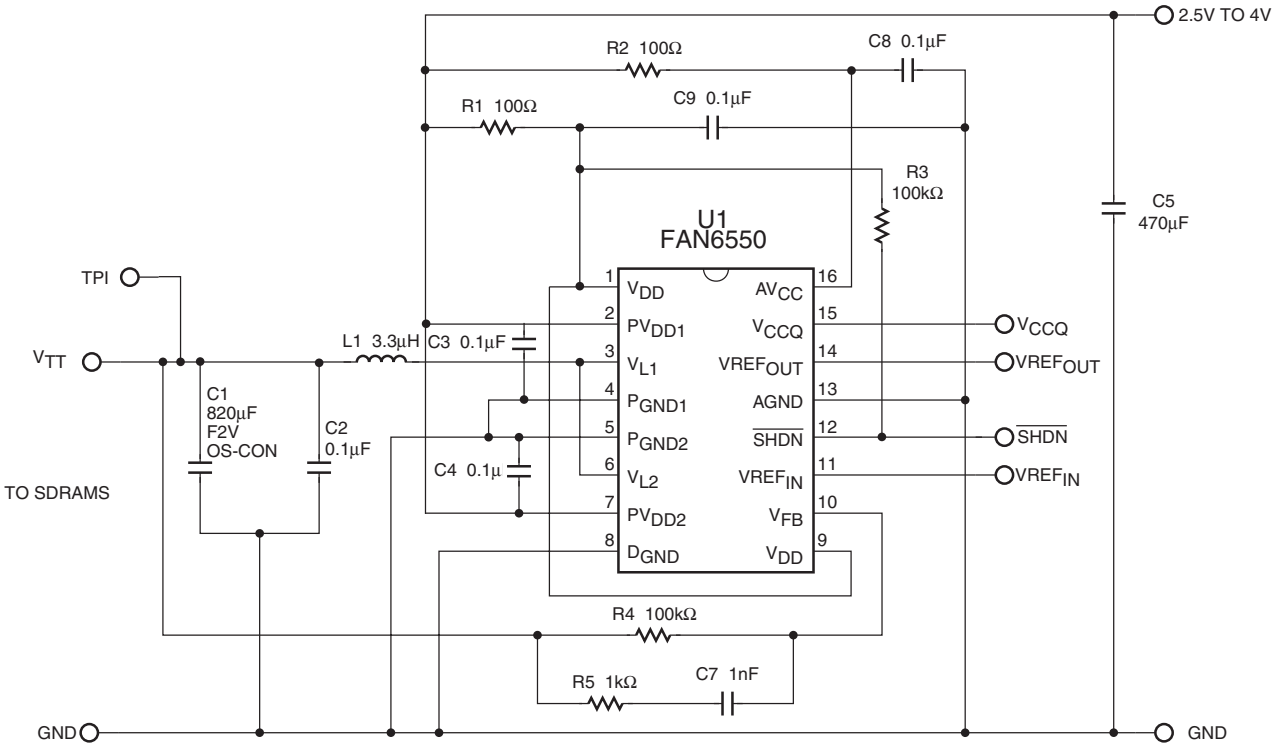


Figure 1.

Applications

Using the FAN6550 for DDR Bus Termination

The circuit schematic in Figure 1 shows a recommended approach for constructing a bus terminating solution for a DDR bus. This circuit can be used in PC memory and Graphics memory applications as shown in Figures 2 and 3. Note that the FAN6550 can provide the voltage reference (V_{REF}) and terminating voltages (V_{TT}). Using the layout as shown in Figures 4, 5, and 6, and measuring the V_{TT} performance using the test setup as described in Figure 7, the FAN6550 delivered a V_{TT} ± 20mV for 1A to 2A loads (see Figure 8). Table 1 provides a recommended parts list.

Bus Termination Solutions for Others Buses

Table 2 provides a summary of various bus termination V_{REF} & V_{TT} requirements. The FAN6550 can be used for those applications.

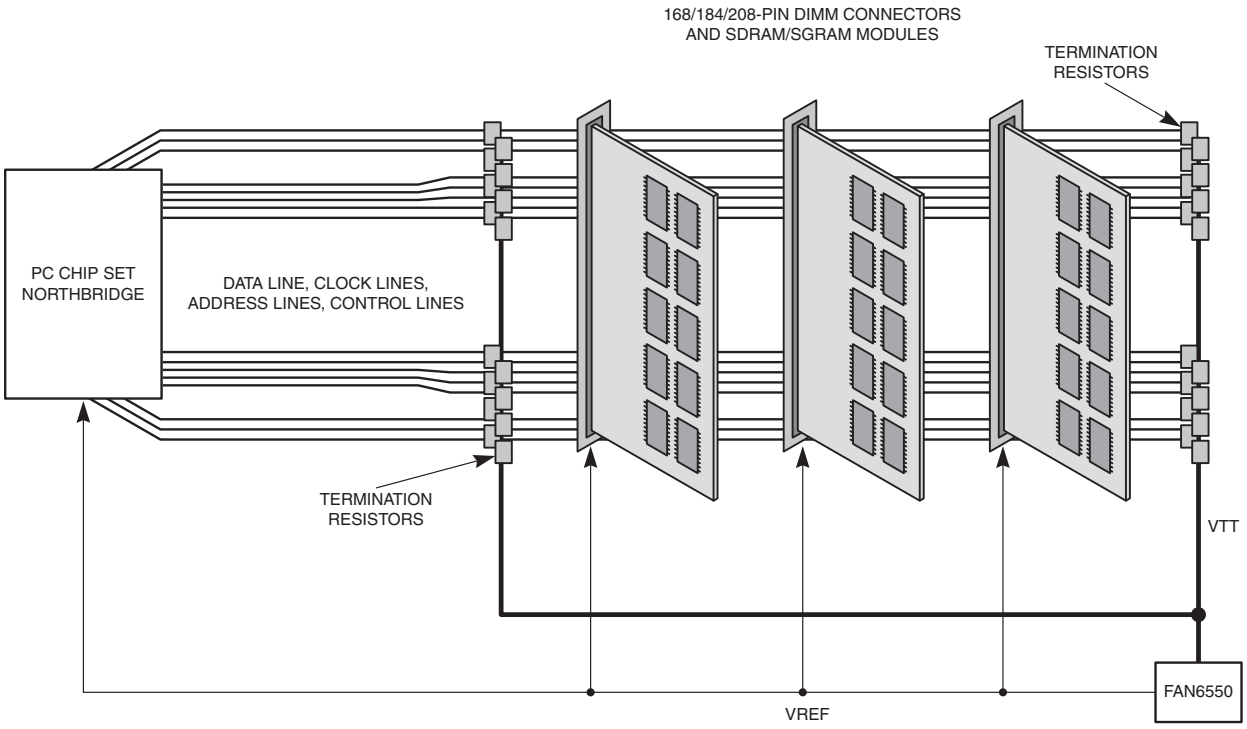


Figure 2. Complete Termination Solution PC Main Memory (PC Motherboard)

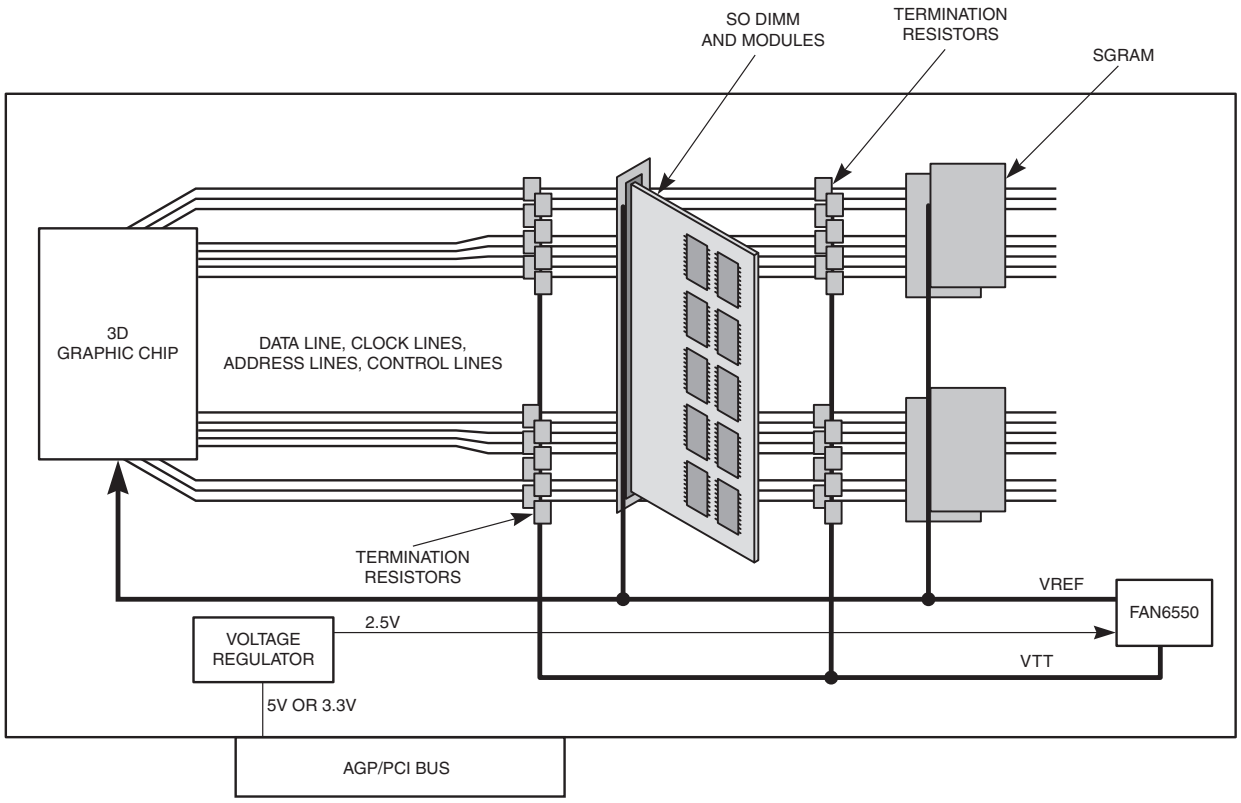


Figure 3. Complete Termination Solution Graphics Memory Bus – AGP Graphics Cards

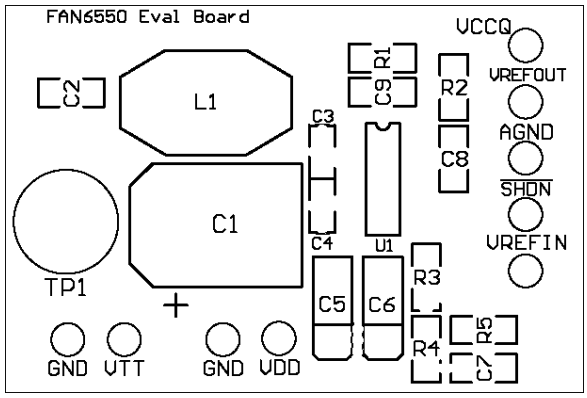


Figure 4. Top Silk

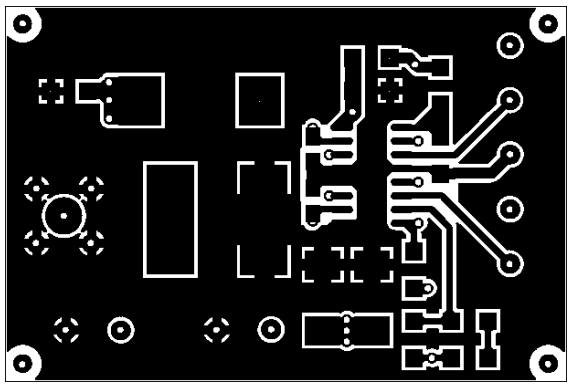


Figure 5. Top Layer

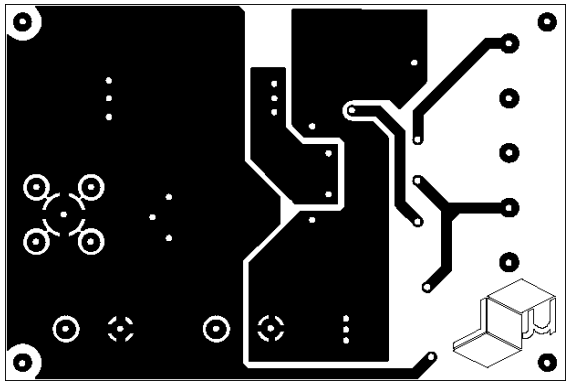


Figure 6. Bottom Layer

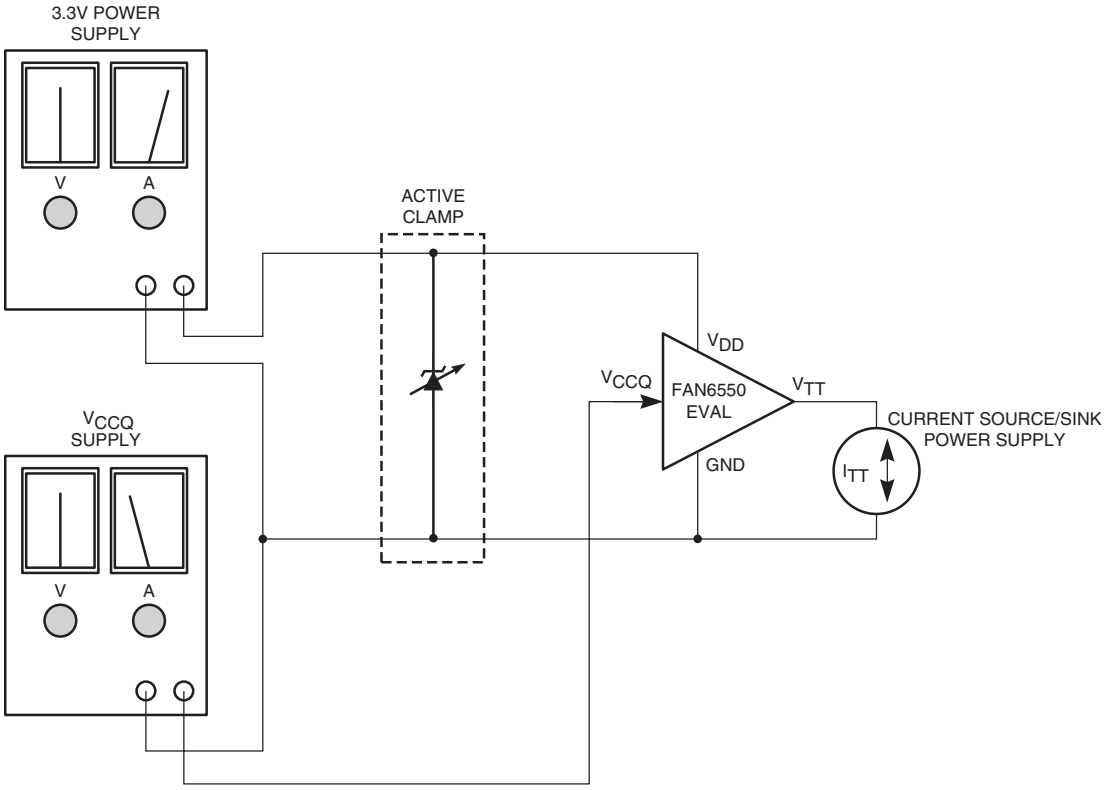


Figure 7. Test Circuit Setup

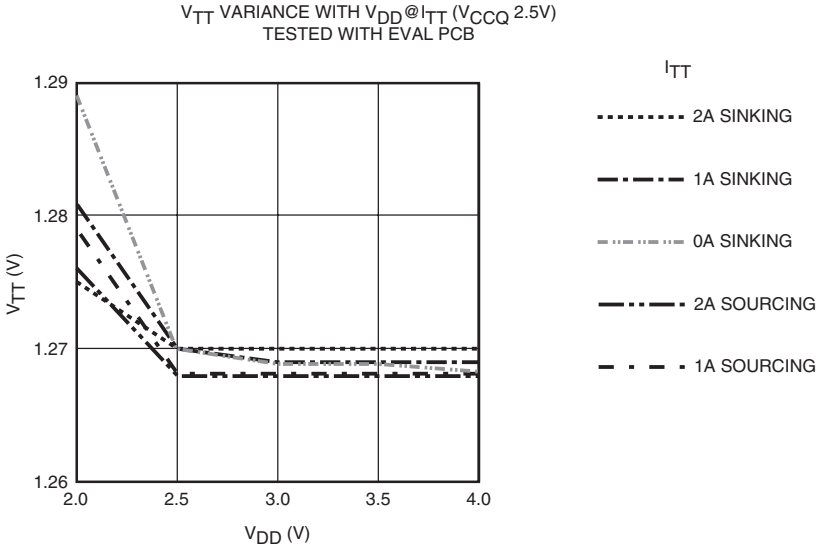


Figure 8. VTT Performance for DDR Bus

Table 1. Recommend Parts List for Figure 1.

Item	Qty	Description	Manufacturer / Part Number	Designator
Resistors				
1	2	100Ω1210 SMD	Panasonic/ERJ-8ENF1000V	R1, R2
2	1	1kΩ 1210 SMD	Panasonic/ERJ-8ENF1001V	R5
3	2	100kΩ1210 SMD	Panasonic/ERJ-8ENF1003V	R3, R4
Capacitors				
4	3	0.1µF 1210 Film SMD	Panasonic/ECV3VB1E104K Panasonic/ECU-V1H104KBW	C2, C8, C9
5	1	820µF 2V Solid Elect. SMD	Sanyo/2SV820M Os Con	C1
6	1	470µF 6.3V Solid Elect. SMD	Sanyo/6SVP470M Os Con	C5
7	1	1nF 1210 Film SMD	Panasonic/ECU-V1H102KBM	C7
8	2	0.1µF 0805 Film	Panasonic/ECJ-2VF1C104Z	C3, C4
ICs				
9	1	FAN6550 Bus Terminator	FAN6550M	U1
Magnetics				
10	1	3.3µH 5A inductor SMD	Coilcraft/D03316P-332HC Pulse Eng./ P0751.332T Gowanda/SMP3316-331M XFMRS inc./XF0046-S4	L1
Other				
11	1	Scope probe socket	Tektronics/131-4353-00	TP1
12	1	12 Pin breakaway strip	Sullins/PTC36SAAN (36 PINS)	I/O, standoffs

Vendor List

1. AVX (207) 282-5111
2. Sanyo (619) 661-6835
3. Tektronix (408) 496-0800
4. Coilcraft (847) 639-6400
5. Pulse (800) 797-8573
6. Gowanda (716) 532-2234
7. Xfmrs Inc. (317) 834-1066
8. Panasonic (714) 373-7366
9. Digikey (800) 344-4539

Table 2. Termination Solutions Summary By Bus Type

Bus	Description	Driving Method	VDDQ	VTT	V_{REF}	Fairchild Solutions	Industry System Components
GTL+	Gunning Transceiver Bus Plus	Open Drain	3.3V Note 10	1.5V±10% Note12	1.0V±2% Note 11	FAN6550; Mode: V_{REF} Input = 1.5V, V_{CC} = 3.3V	300 to 500MHz Processor; PC Chipsets; GTLP 16xxx Buffers; Fairchild, Texas Instr.
DDR (SSTL-2)	Series Stub Terminated Logic for 2V	Symmetric Drive, Series Resistance	2.5V±10%	0.5x (V_{DDQ}) ±3%	2.5V	FAN6550, ML6554CU, or ML6553CS; Mode: V_{REF} Input = Floating or Forced, V_{CC} = 3.3V	DDR SDRAM; Hitachi, Fujitsu, NEC, Micro, Mitsubishi
RAMBUS	RAMBUS Signaling Logic	Open Drain	None Specified	2.5V	2.0V	ML6553CS; Mode: V_{REF} Input = Open, V_{CC} = V_{DDQ}	nDRAM, RAMBUS, Intel, Toshiba
LV-TTL	Low Voltage TTL Logic or PECL or 3.3V VME	Symmetric Drive	3.3±10%	V_{DDQ}/2	3.3V	ML6553CS; Mode: V_{REF} Input = Open, VCC = VDDQ	Processors or backplanes; LV-TTL SDRAM, EDO RAM

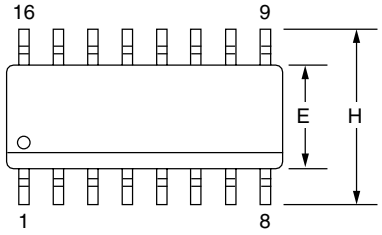
Mechanical Dimensions Inches (Millimeters)

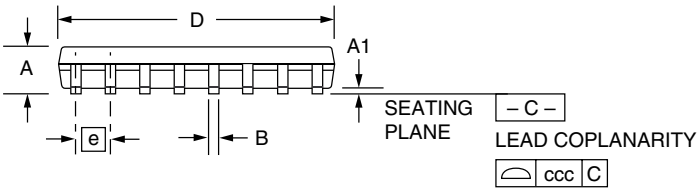
Package: M16 16-Pin SOIC

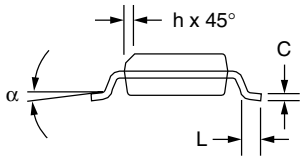
Symbol	Inches		Millimeters		Notes
	Min.	Max.	Min.	Max.	
A	.053	.069	1.35	1.75	
A1	.004	.010	0.10	0.25	
B	.013	.020	0.33	0.51	
C	.0075	.010	0.19	0.25	5
D	.386	.394	9.80	10.00	2
E	.150	.158	3.81	4.00	2
e	.050 BSC		1.27 BSC		
H	.228	.244	5.80	6.20	
h	.010	.020	0.25	0.50	
L	.016	.050	0.40	1.27	3
N	16		16		6
α	0°	8°	0°	8°	
ccc	—	.004	—	0.10	

Notes:

1. Dimensioning and tolerancing per ANSI Y14.5M-1982.
2. "D" and "E" do not include mold flash. Mold flash or protrusions shall not exceed .010 inch (0.25mm).
3. "L" is the length of terminal for soldering to a substrate.
4. Terminal numbers are shown for reference only.
5. "C" dimension does not include solder finish thickness.
6. Symbol "N" is the maximum number of terminals.







Ordering Information

Part Number	Temperature Range	Package	Packing
FAN6550M	0°C to 70°C	16-Pin SOIC (M16)	Rails
FAN6550MX	0°C to 70°C	16-Pin SOIC (M16)	Tape and Reel

3/11/02 0.0m 002
Stock#DS30006550