
Advanced Bus Interface & Standard Logic



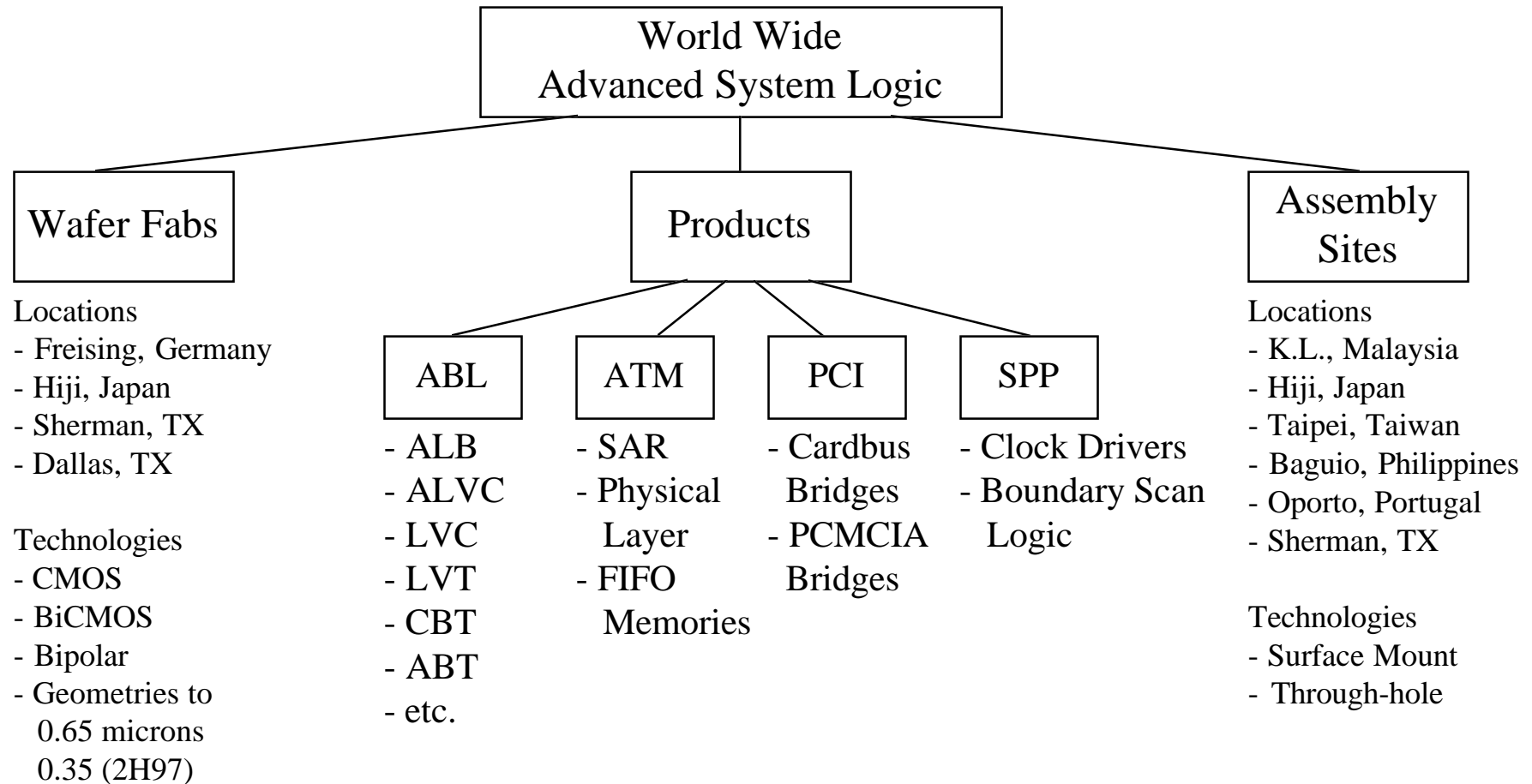
One Stop Logic Shop!

Advanced System Logic Products

1997



Advanced System Logic





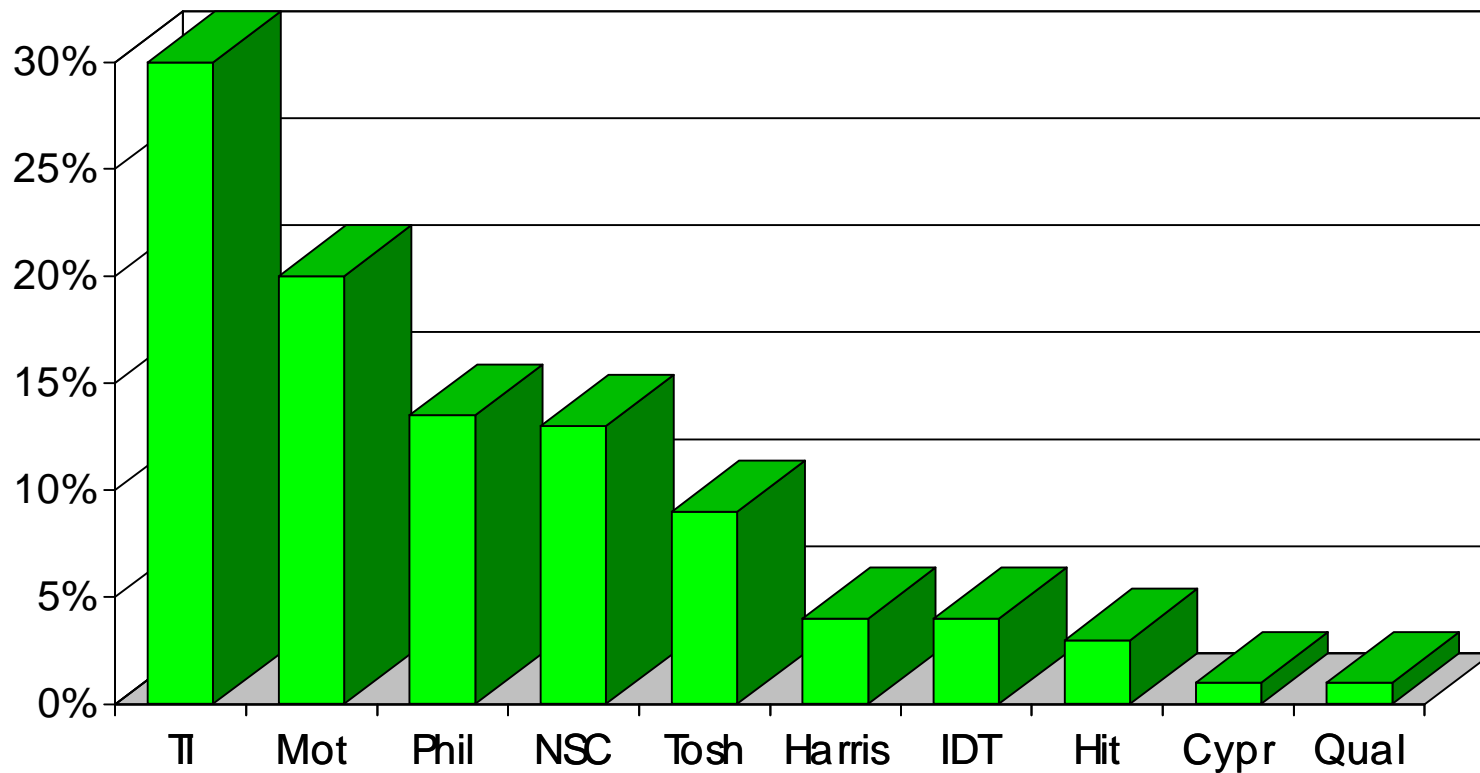
Agenda

- Logic Overview - One Stop Logic Shop!
- Packaging Trends
- 5V logic products
 - AHC, AHC MicroGates, ABT, CBT
- 3.3V logic products
 - 5V Tolerant - LVT, LVC, ALVT
 - Pure 3.3V LV, ALVC, ALB
- Specialty Logic Features (Bus Hold, Resistors)
- High-Performance backplane products
- Clock Drivers/JTAG/FIFO's



Logic Sourcing Analysis

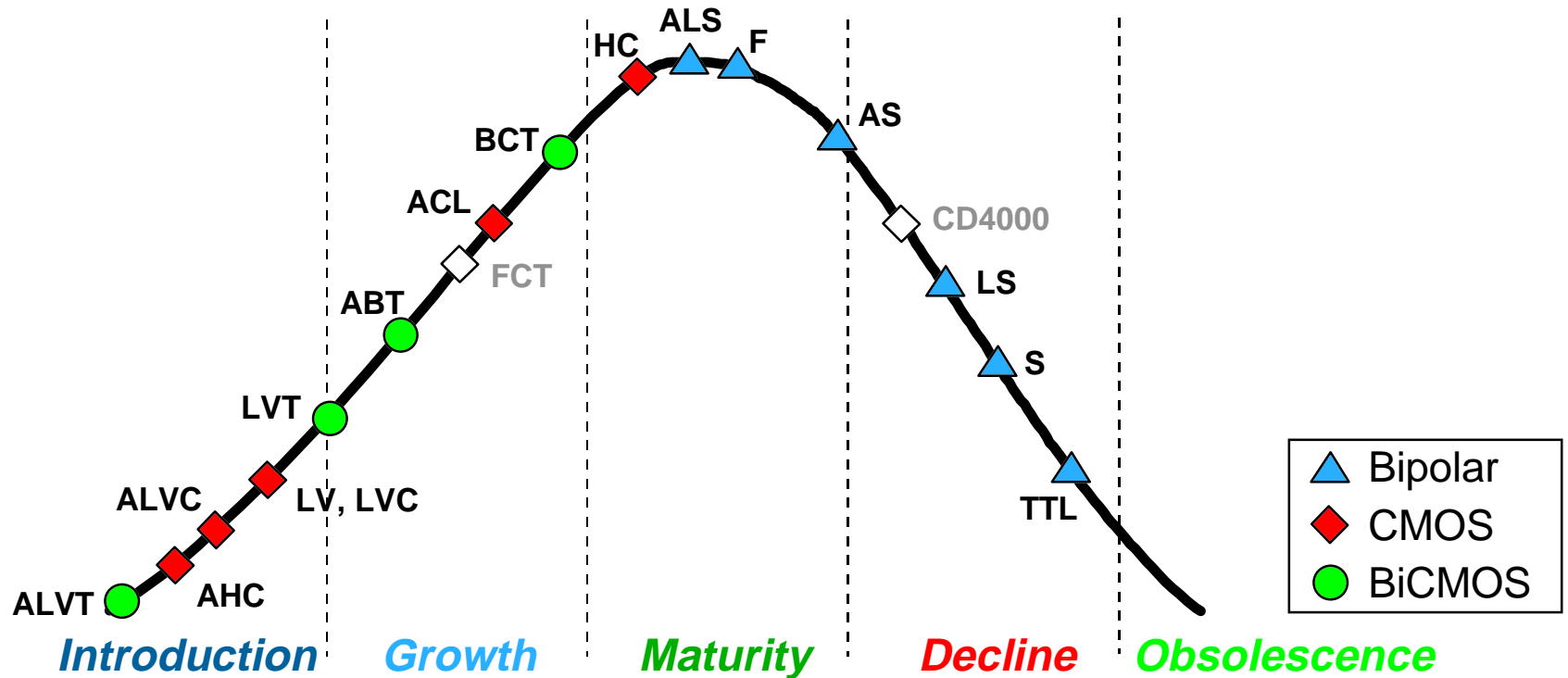
1995 U.S. Market Share (All Products)



Source: Insight Onsite



Product Life Cycle

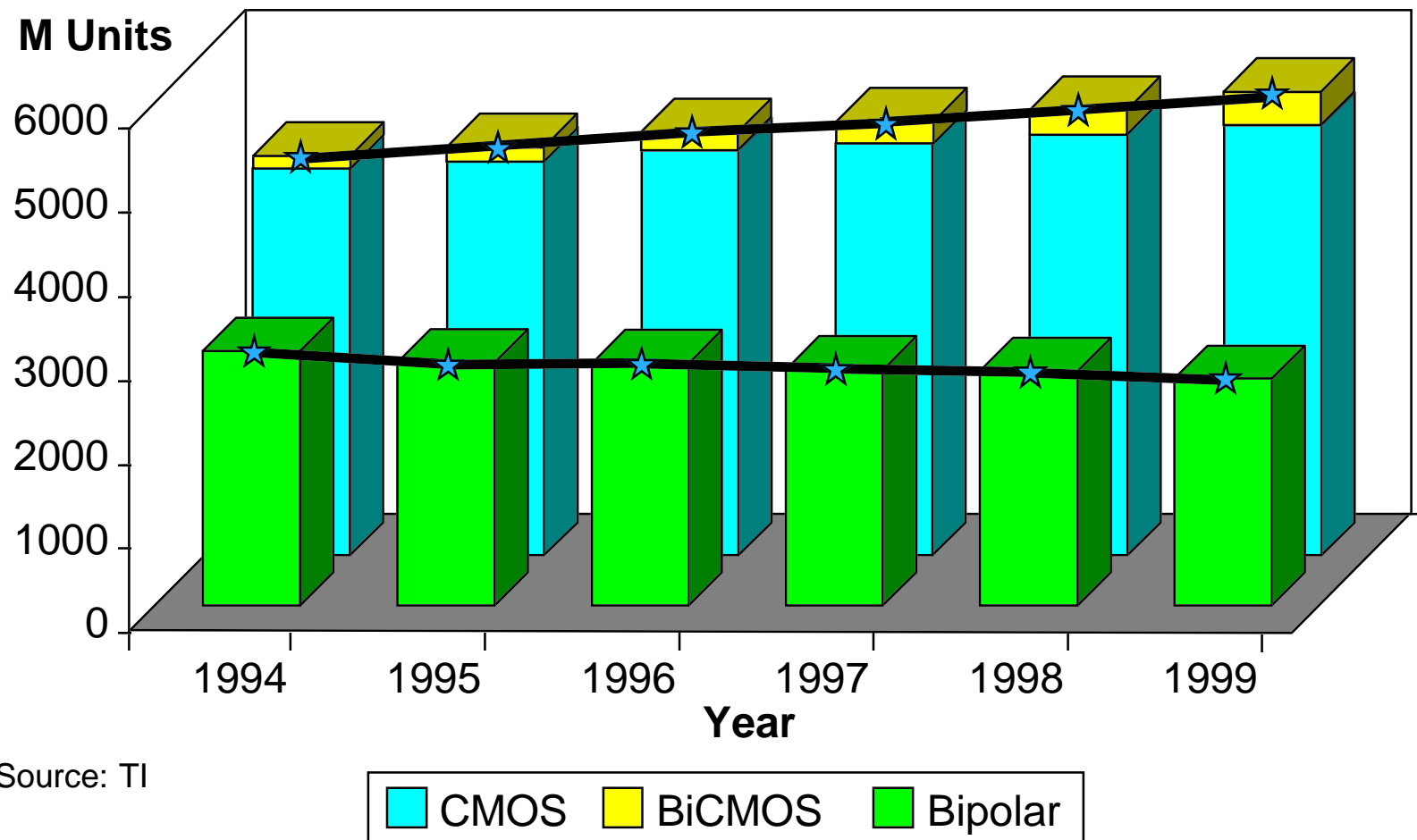


- TI remains committed to be the last supplier in the older families.
- Investment levels for new products are at an all time high while end equipment requirements are accelerating new product introduction.



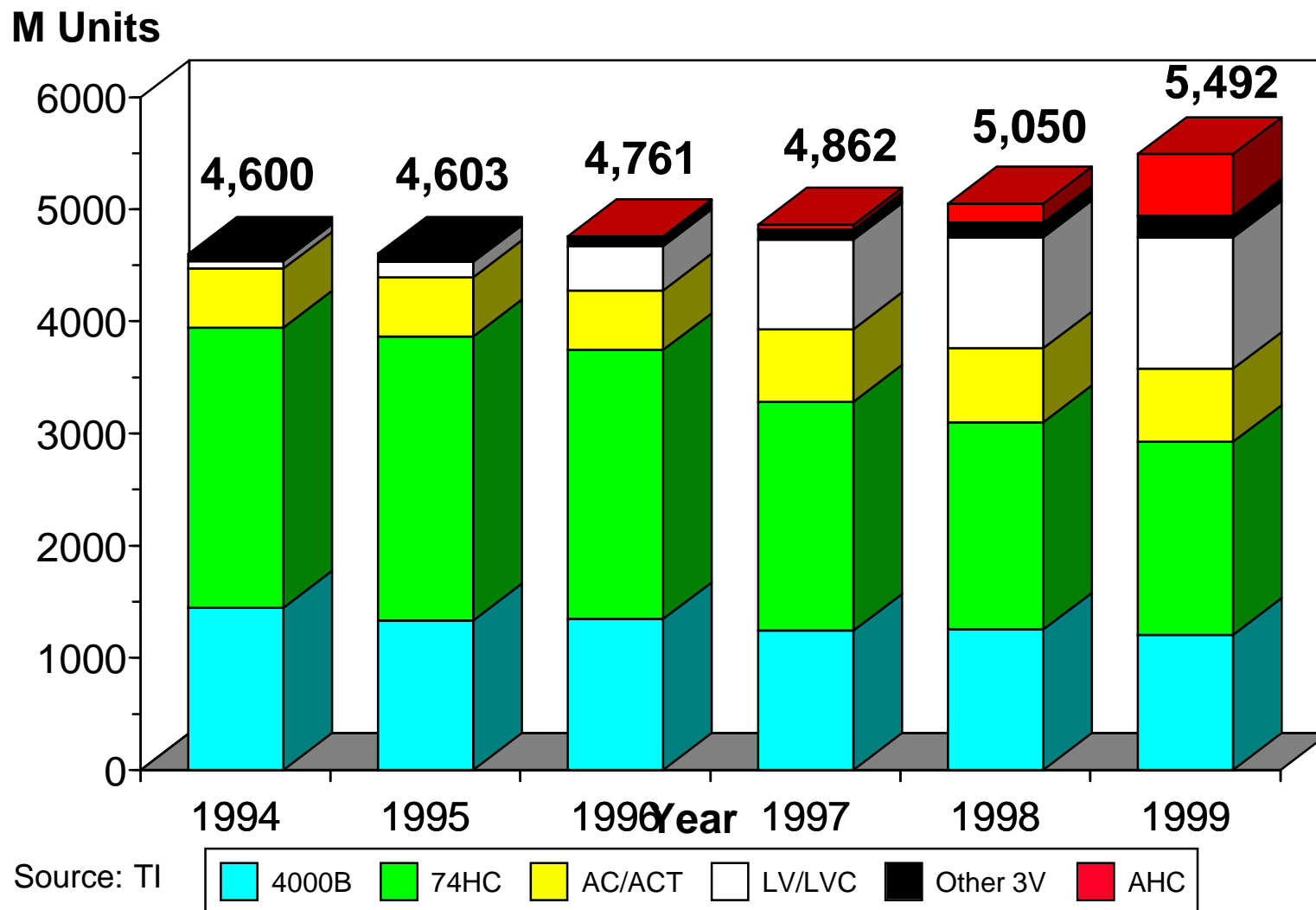
CMOS is Growing, Bipolar is Shrinking

Worldwide Standard Logic Market





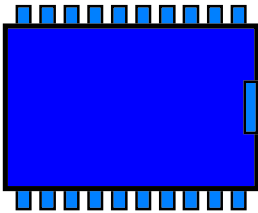
Worldwide CMOS Logic Market





Packaging Options

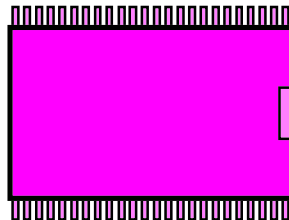
8 Bits



20-Pin SOIC (DW)

Area = 137 mm²
Height = 2.65 mm
Lead Pitch = 1.27 mm

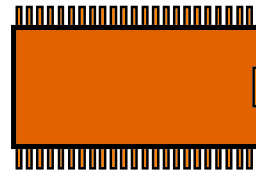
**16/18 Bits
Widebus™**



48-Pin SSOP (DL)

Area = 171 mm²
Height = 2.74 mm
Lead Pitch = 0.635 mm

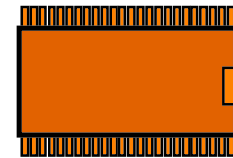
**16/18 Bits
TSSOP**



48-Pin TSSOP (DGG)

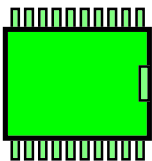
Area = 108 mm²
Height = 1.1 mm
Lead Pitch = 0.5 mm

**16/18 Bits
TVSOP**



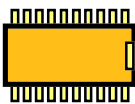
48-Pin TVSOP (DGV)

Area = 63 mm²
Height = 1.2 mm
Lead Pitch = 0.4 mm



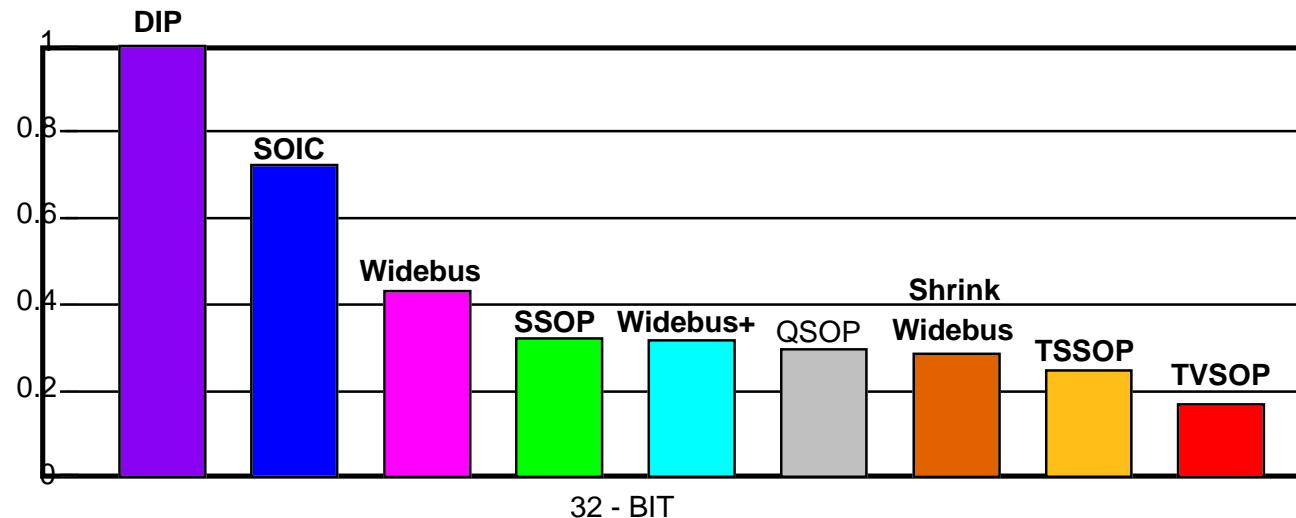
20-Pin SSOP (DB)

Area = 62 mm²
Height = 2.0 mm
Lead Pitch = 0.65 mm



20-Pin TSSOP (PW)

Area = 46 mm²
Height = 1.1 mm
Lead Pitch = 0.65 mm



Bold indicates TI TTL/CMOS logic packages.

(TI package designers)

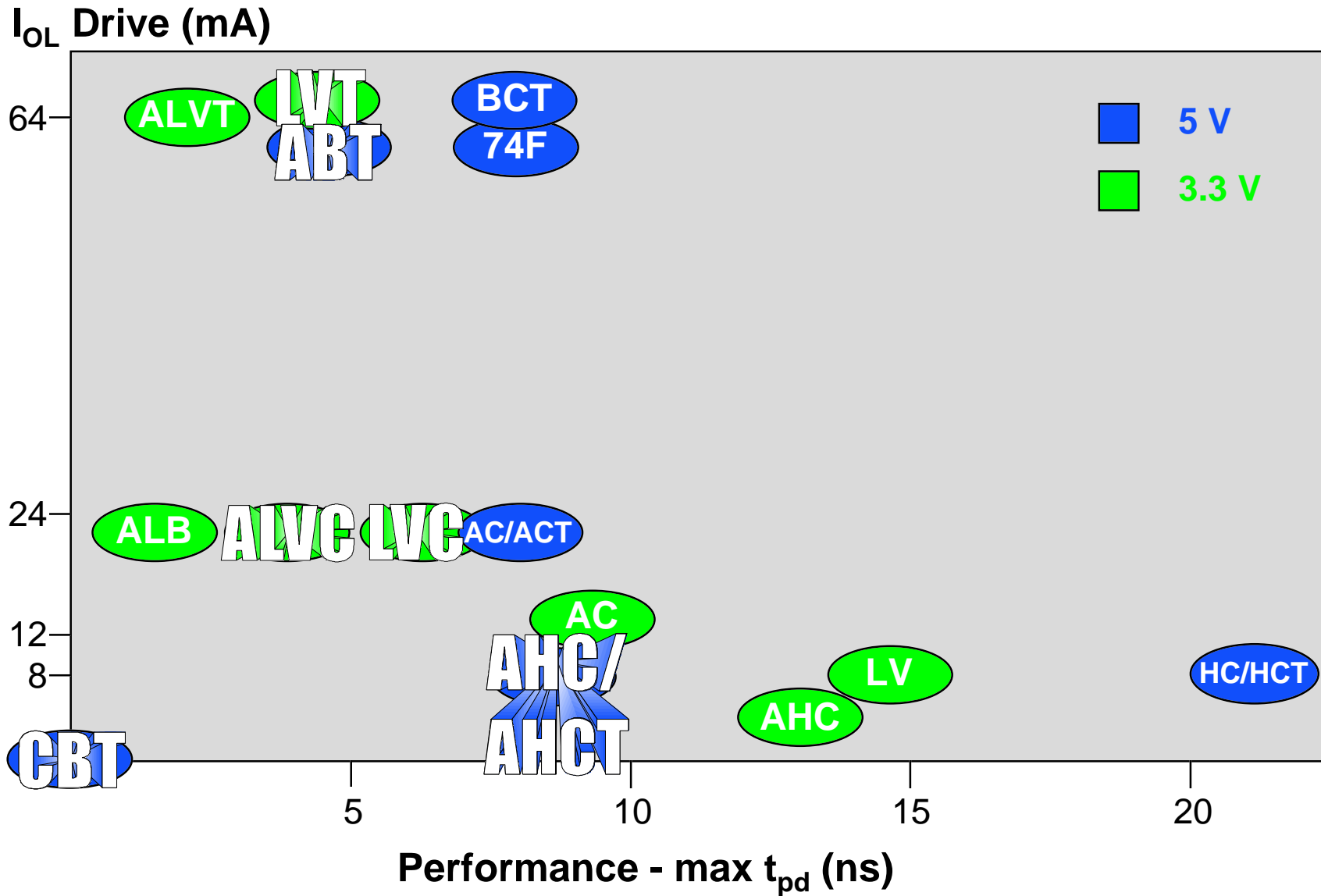


Bus Switch Package Options

Package	Type	TI	IDT	QSI	Pericom	Cypress	FSC	Other families supported
PDIP		N/NT	P	P	P	P	N	all
SOIC		D/DW	SO	S1/SO	W/S	SO	M/WM	all
SOJ					G	V		few
QSOP	Std		Q	Q	Q	Q	QS	FCT
QVSOP	WB			Q1	B			FCT
SSOP	Std	DB	PY		H		MSA	most CMOS/BiCMOS
	WB	DL	PV	PV	V	PV	MEA	all CMOS/BiCMOS
TSSOP	Std	PW	PG		L	P	MTC	all CMOS/BiCMOS
	WB	DGG	PA	PA	A	PA	MTD	all CMOS/BiCMOS
TVSOP	Std	DGV						ABT,AHC,LV,LVC
	WB	DGV	tbd					ABT,AHC,LVC,ALVC



Family Positioning





Advanced High-Speed CMOS - AHC/AHCT

Circuit Features

Gates, Flip-Flops, and Bus Functions
Available in CMOS & TTL Compatible Functions
Low Noise
High Noise Immunity
2.0V to 5.5V Supply Voltage

Advantages

Three Times Faster Than HC
Similar Noise Performance to HC
Similar Pricing to HC
Marketing & Applications Support
Internal & External 2nd Sources
Drop in replaceable to VHC
Broad Product Portfolio
Performance/Price

Performance

'245 { 5.5 ns typ t_{pd}
8.5 ns max t_{pd}
8 mA Drive 5V
4 mA Drive 3.3V

Packaging

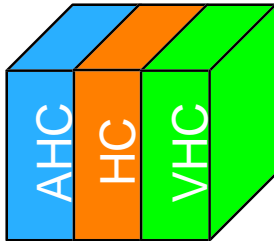
PDIP
SOIC
SSOP
TSSOP
TVSOP*

*Planned

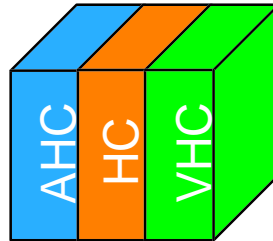


Key Comparisons

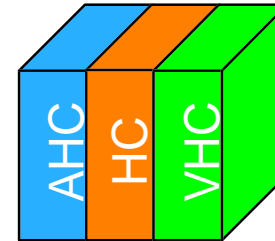
AHC/HC/VHC



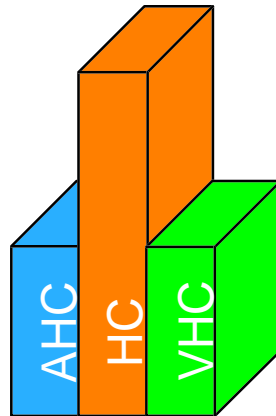
Ground Bounce
(V_{OLP})



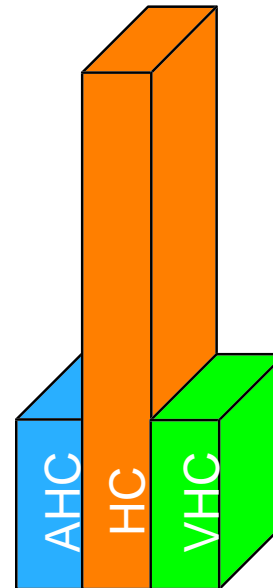
Drive - I_{OL}



Dynamic Power Consumption



Static Power Consumption



Propagation Delay

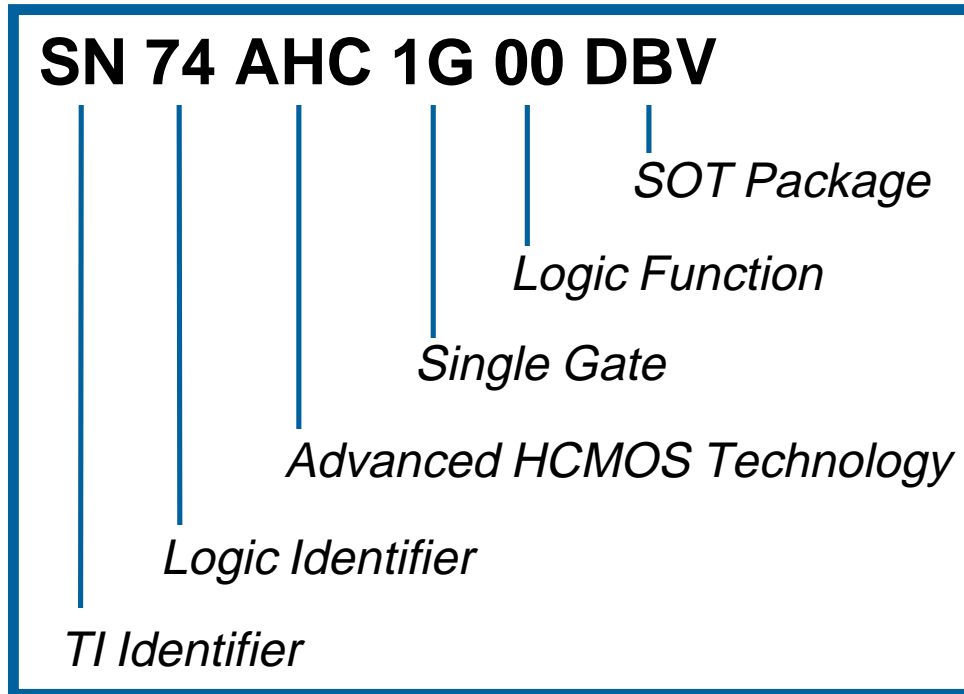


AHC/AHCT Product Offerings

Released			Planned	
AHC00	AHC86	AHC373	AHC138	AHC273
AHCT00	AHCT86	AHCT373	AHCT138	AHCT273
AHC04	AHC125	AHC374	AHC139	AHC02
AHCU04	AHCT125	AHCT374	AHCT139	AHCT02
AHCT04	AHC126	AHC540	AHC157	
AHC08	AHCT126	AHCT540	AHCT157	
AHCT08	AHC240	AHC541	AHC158	
AHC14	AHCT240	AHCT541	AHCT158	
AHCT14	AHC244	AHC573	AHC257	
AHC32	AHCT244	AHCT573	AHCT257	
AHCT32	AHC245	AHC574	AHC258	
AHC74	AHCT245	AHCT574	AHCT258	
AHCT74				

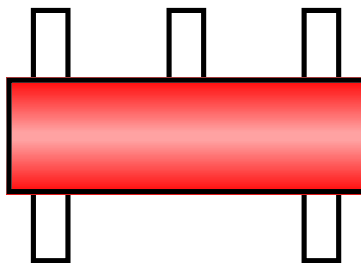


AHC/AHCT MicroGates



- ◆ Simplifies circuit routing
- ◆ ASIC modification
- ◆ 3.5 ns typ propagation delay
- ◆ +/-8mA output drive
- ◆ 20uA static current
- ◆ CMOS (AHC) and TTL (AHCT) versions
- ◆ Compatible with Toshiba's TC7SH/SHTxx series
- ◆ Volume production: now

Cross-Reference (examples)



Texas Instruments	Toshiba
SN74AHC1G00DBV	TC7SH00F
SN74AHCT1G00DBV	TC7SHT00F
SN74AHC1GU04DBV	TC7SHU04F



AHC/AHCT MicroGate Product Offerings

Released	Planned
AHC1G00	AHC1G02
AHCT1G00	AHCT1G02
AHC1G08	AHC1G04
AHCT1G08	AHC1GU04
AHC1G32	AHCT1G04
AHCT1G32	AHC1G14
	AHCT1G14
	AHC1G86
	AHCT1G86



Advanced BiCMOS Technology - ABT

Circuit Features

- 0.8 μ BiCMOS Technology
- Power-Up 3-State
- Power-On-Demand (I_{CCL})*
- Bus Hold ($I_{i(HOLD)}$)*
- Live Insertion (I_{OFF})
- Industrial Temp (-40 to 85°C)
- Damping Resistor Option
- Reduced V_{OLP}

* Selected functions

Advantages

- Low Power CMOS
- High Drive Bipolar Outputs
- Marketing & Applications Support
- SPICE Models
- Internal & External 2nd Sources
- Broad Product Portfolio
- Performance/Price

Performance

'245A - 3.9 ns	} max t_{pd}
'16245A - 4.2 ns	

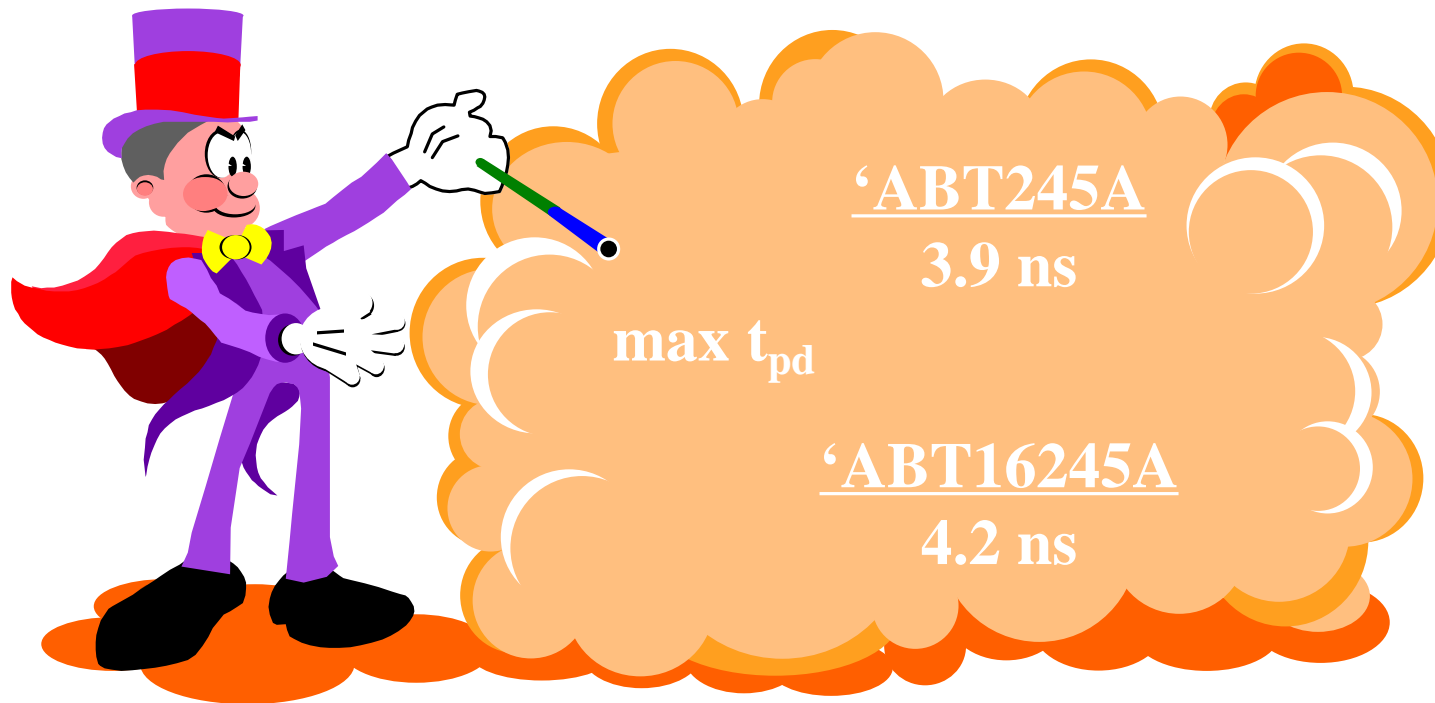
Packaging

- DIP
- SOIC
- SSOP
- TSSOP
- Widebus™
- Shrink Widebus™
- TQFP

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ABT is Fast!



<u>FCT245</u>		
A	C	E
4.6	4.1	3.2

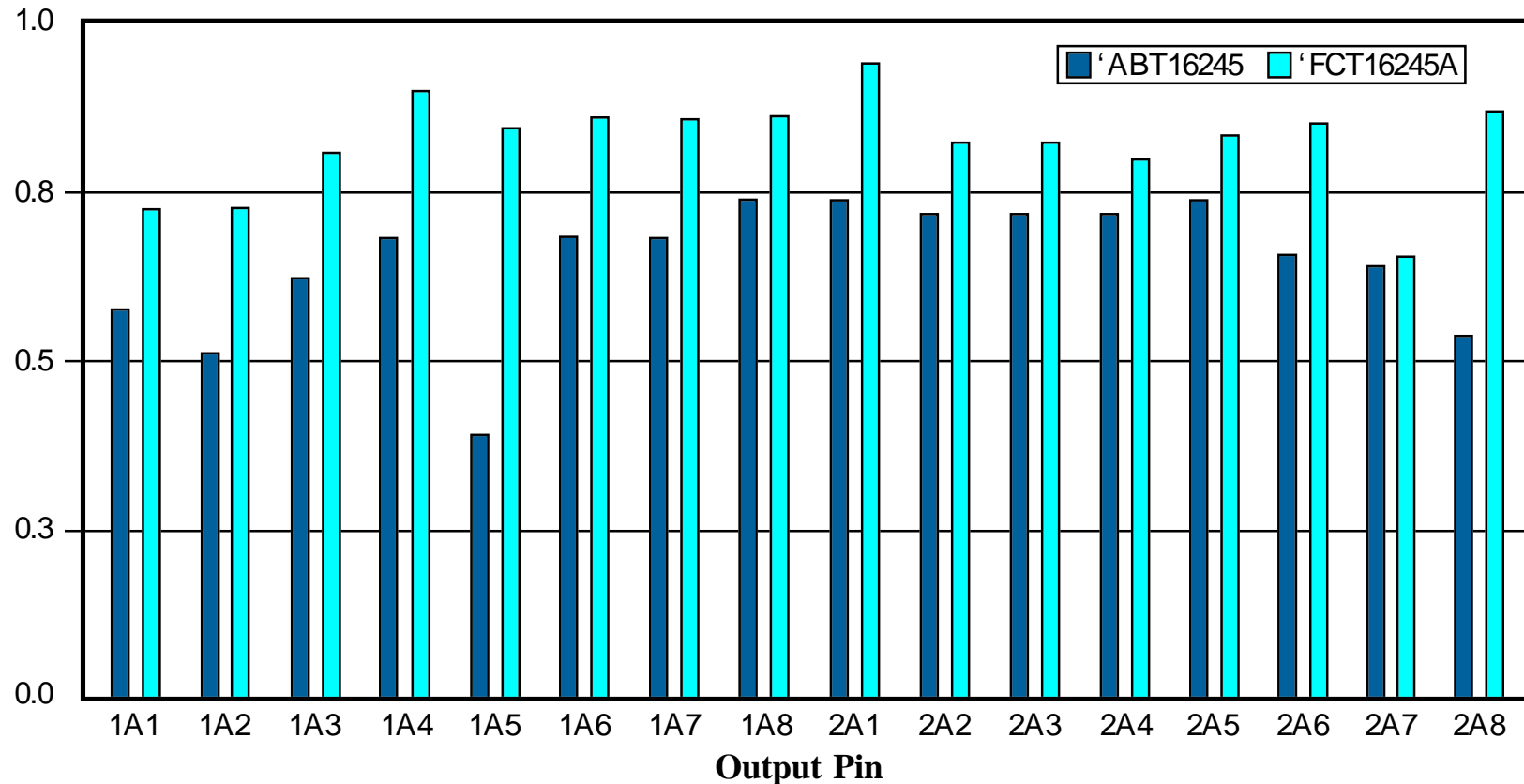
<u>FCT16245</u>		
A	C	E
4.5	4.1	3.2

ABT is price competitive to FCT!



ABT Has Lower Ground Bounce!

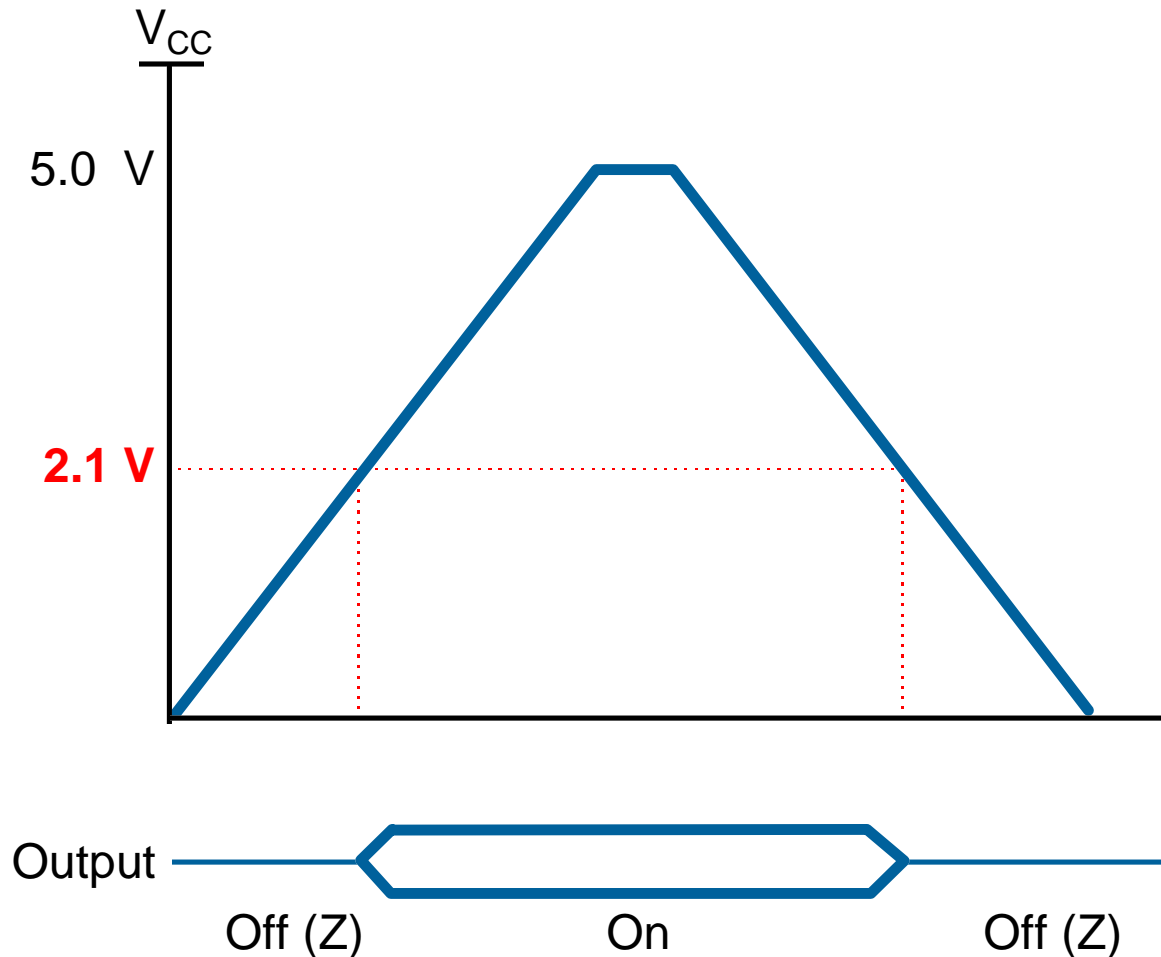
V_{OLP}



$V_{CC} = 5.5V$, $C_L = 50$ pF, $R_L = 500\Omega$, 15 Outputs Switching,
Freq = 1 MHz, $T_A = 25^\circ C$, $V_{INL} = 0.5V$, $V_{INH} = 2.5V$



ABT Has Power Up 3-State!



- To ensure valid output levels during power up

— I_{OZpu} , I_{OZpd} on data sheet

- To ensure high Z on output during power down

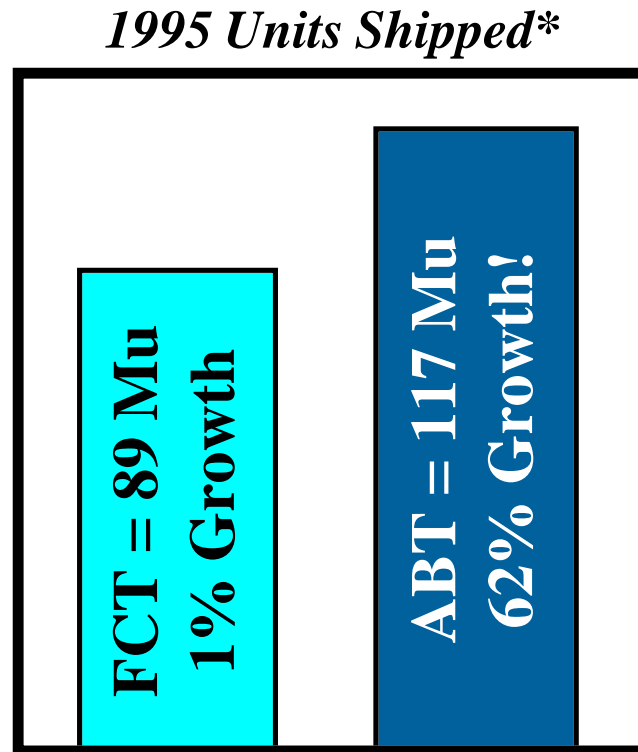
— I_{OFF} on data sheet



Why ABT Rather Than FCT?

ABT and FCT

- High performance
- Live insertion
- Competitive pricing
- Bus hold (selected functions)



ABT is the Clear Winner!

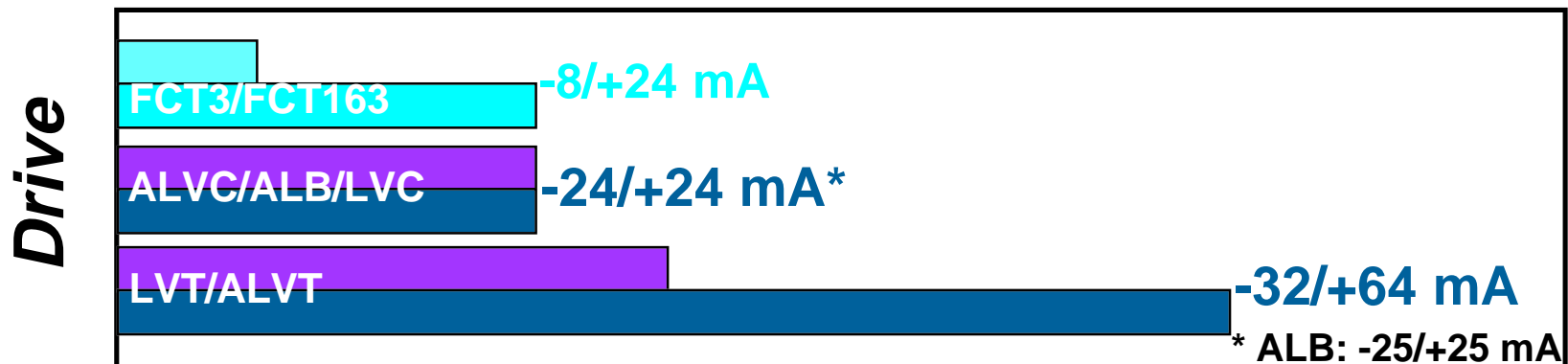
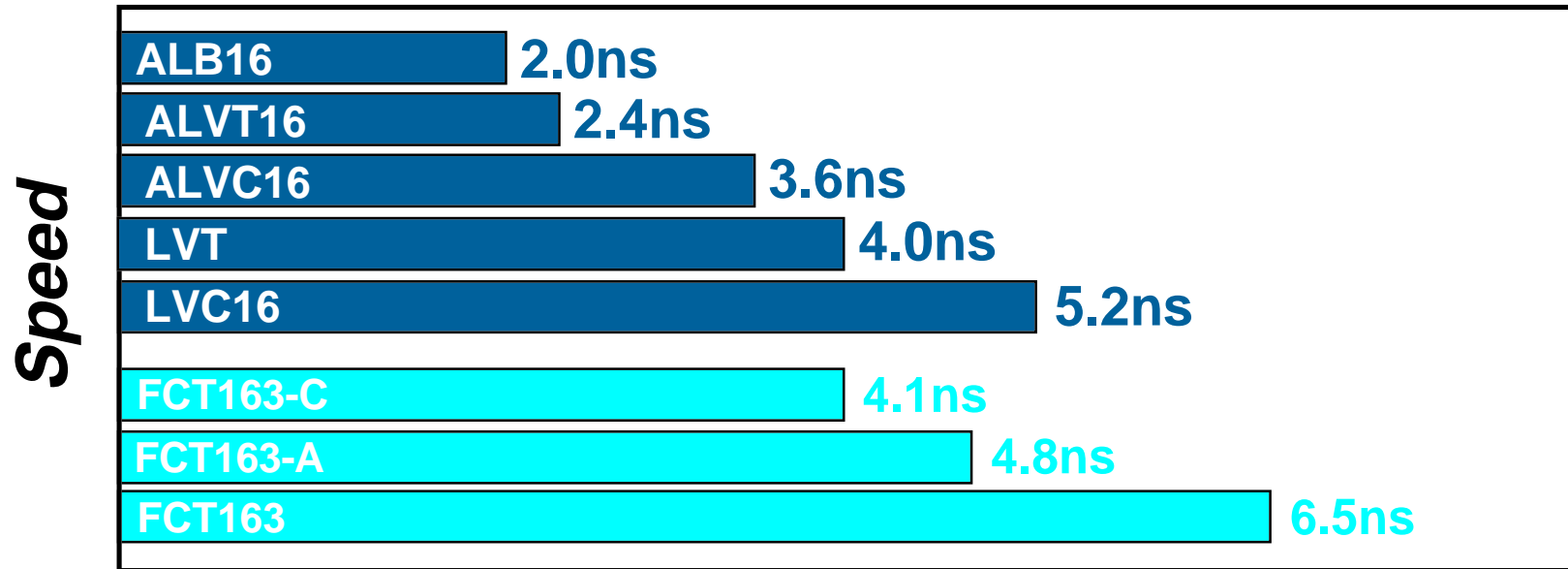
ABT Only

- ◆ Lower ground bounce
- ◆ Power up 3-state
- ◆ Stronger 2nd sourcing
 - TI/Philips/Hitachi/Fairchild (NSC)/Toshiba

Plus, TI provides a complete roadmap to lower voltages!



TI Provides a Faster, More Complete Roadmap to Lower Voltages!





Cross Bar Technology - CBT

Circuit Features

- Low r_{on} ($5\ \Omega$)
- Low C_i (4.5 pF)
- Industry Standard Pinouts
- Pre-Charge Circuits for Live Insertion

Advantages

- Isolate circuits
- 5V to 3.3V translation
- I_l spec'd up to 64 mA
- Innovative Widebus™ Functions Available
- Marketing & Applications Support
- SPICE Models

Widebus is a trademark of Texas Instruments Incorporated

Performance

250 ps MAX Prop Delay!

Packaging

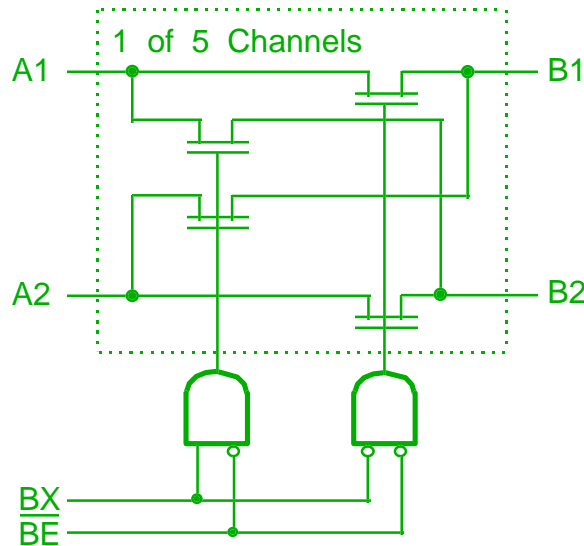
- SOIC
- SSOP
- TSSOP
- Widebus™
- Shrink Widebus™

Shrink Widebus is a trademark of Texas Instruments Incorporated



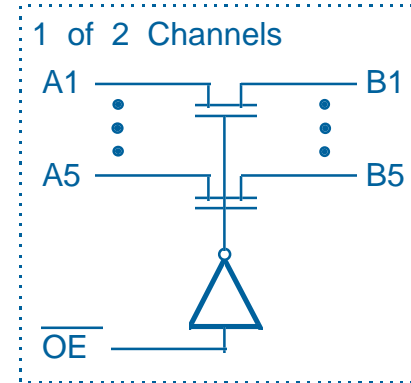
CBT Bus Exchange Switches

CBT3383 BUS EXCHANGER



- Simple FET Switches
- Functionally Equivalent To: QS3383 and QS3384
- Industry Standard Pinouts ('244, '245)
- Widebus™ Functions Available
- Fine Pitch Packaging Options (SOIC, SSOP, TSSOP, Widebus, Shrink Widebus™)
- Octals and Widebus available NOW!

CBT3384A BUS SWITCH



CBT DEVICE TYPES

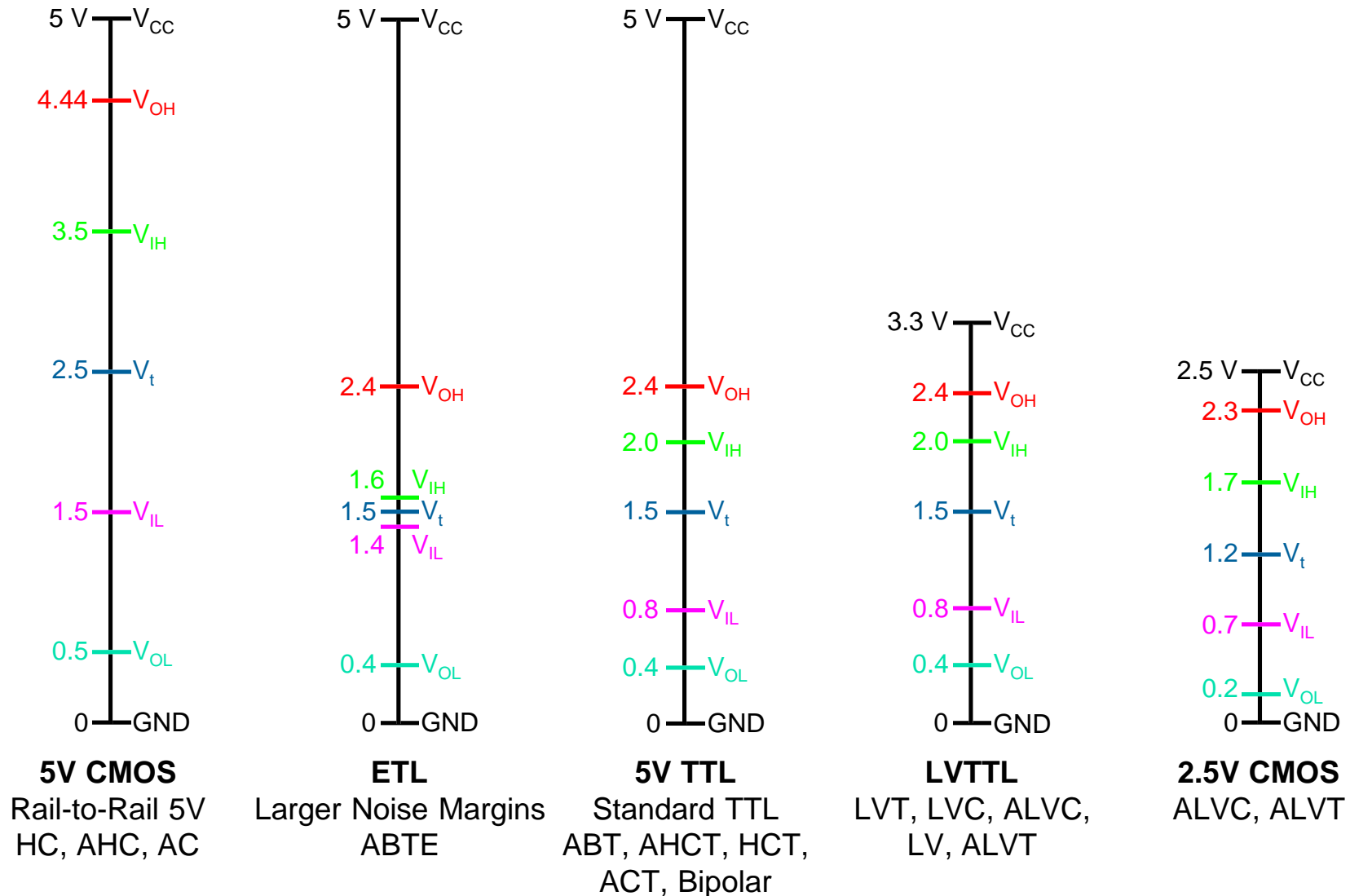
'3306	2-Bit Bus Switch
'3125	4-Bit Bus Switch
'3244	8-Bit, '244 Pinout
'3245A/3345	8-Bit, '245 Pinout
'3253	Dual 4-to-1-Multiplexers
'3257	Quad 2-to-1-Multiplexers
'3383	10-Bit Bus Exchanger
'3384A	10-Bit Bus Switch
'6800	10-Bit VME64 Switch
'16209	18-Bit Bus Exchanger
'16211	24-Bit Bus Switch
'16212/16213	24-Bit Bus Exchanger
'16214	12-Bit 3-to-1 Bus Select
'16244	16-Bit Bus Switch

Widebus and Shrink Widebus are trademarks of Texas Instruments Incorporated



IC Basics

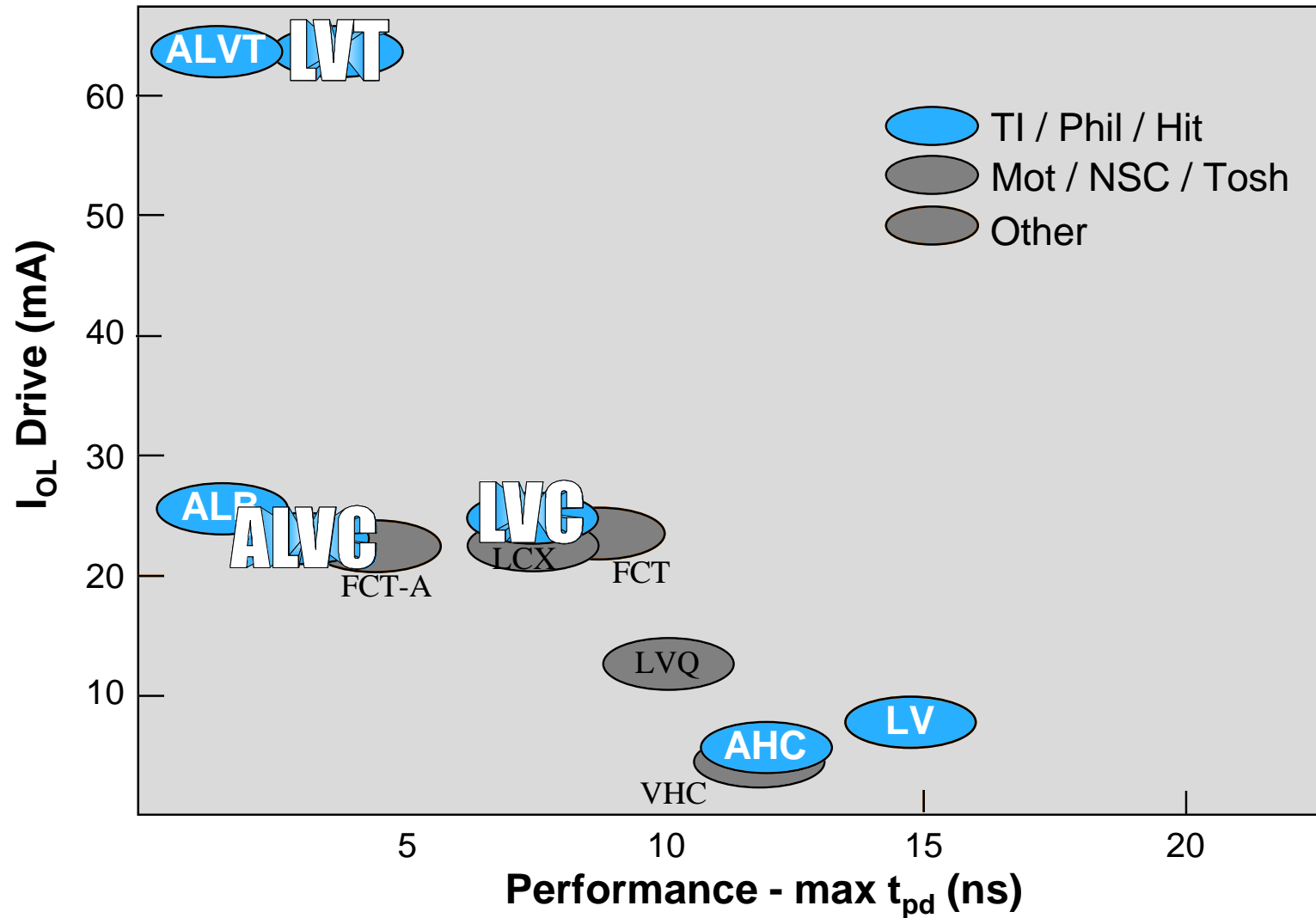
Comparison of Switching Standards





Low Voltage Logic

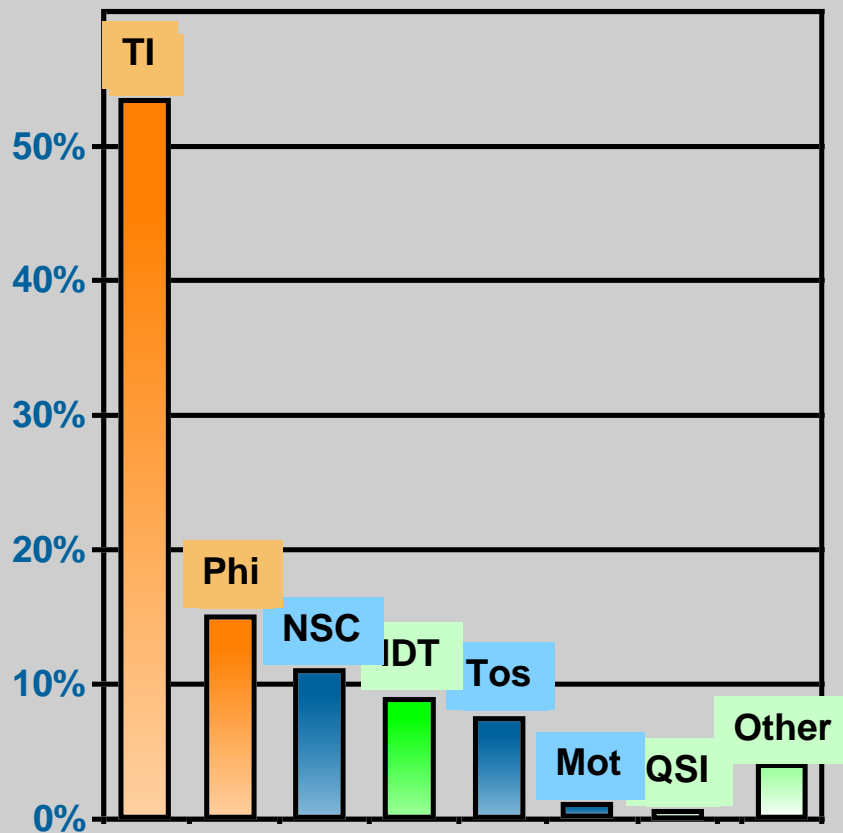
3.3V Competitive Analysis



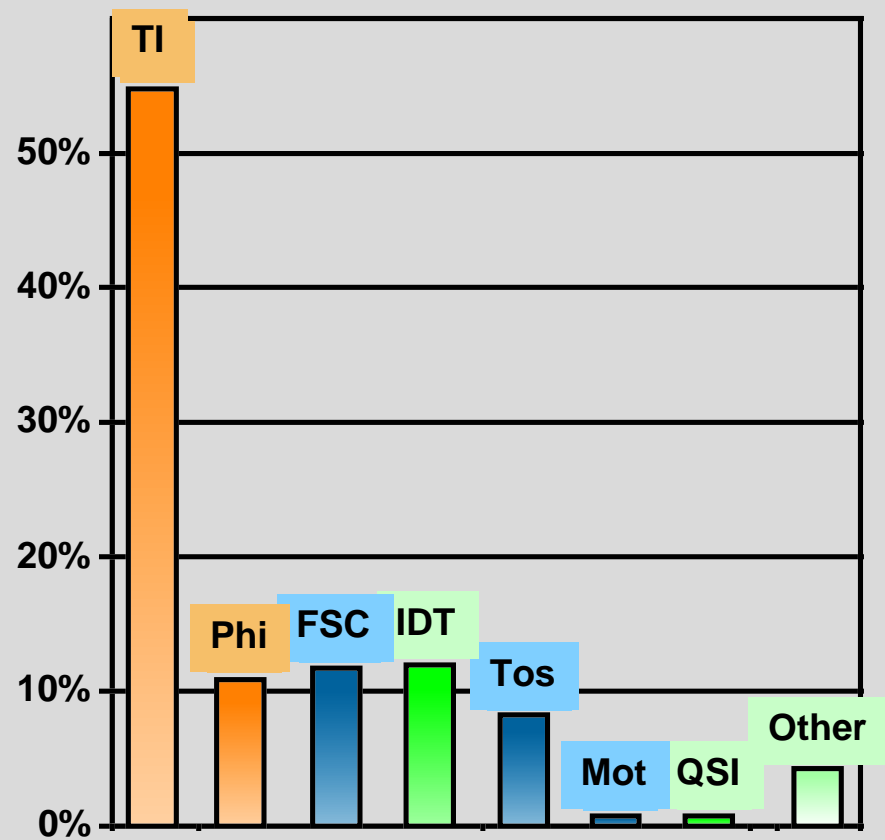


#1 in Low Voltage Logic: TI

1995 3.3V Logic Market Shares



1996* 3.3V Logic Market Shares

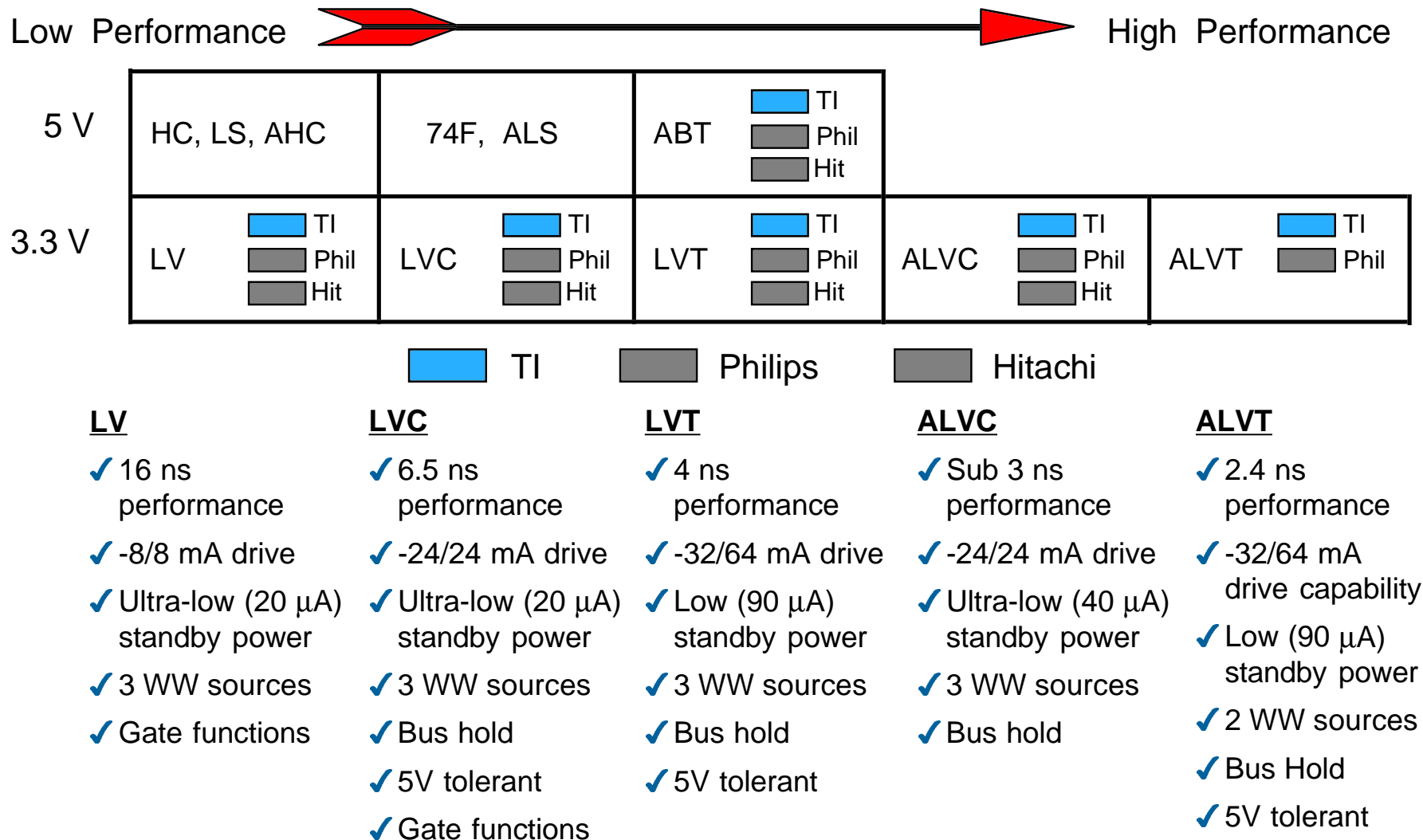


* as of 10/1/96

Source: Insight Onsite



Complete Low Voltage Market Coverage and Standardization





Low Voltage Technology - LVT

Circuit Features

- Mixed Mode - 5V TTL - Compatible
- Bus Hold ($I_{I(HOLD)}$)
- Power - On - Demand
- High Drive (-32/64 mA)
- Low Noise
- Damping Resistor Options
- ESD Protection
- $V_{IMAX} = 7V$ DC
- Live Insertion (I_{OFF})

Advantages

- Migrate from 5V to 3.3V with minimum redesign
- Marketing & Applications Support
- SPICE Models
- Internal & External 2nd Sources
- Wide Product Portfolio

Performance

- '245 - 4.4 ns max t_{pd}
- '16245A - 4.1 ns max t_{pd}
- Standby Power = 90 μA

Packaging

- SOIC
- SSOP
- TSSOP
- Widebus™
- Shrink Widebus™

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Low Voltage CMOS - LVC

Circuit Features

- Gates Available
- 24/24 mA Drive
- No Diode to V_{CC}
- 5V Tolerant *
- Bus Hold **
- Damping Resistor Options

* redesign program on-going
** selected functions

Advantages

- Mid-Range Low Voltage Product (performance/price)
- Lower Power Dissipation Capacitance (C_{pd})
- Lower Input/Output Capacitance (C_{IN}/C_{OUT})
- Marketing & Applications Support
- SPICE Models
- Internal & External 2nd Sources
- Wide Product Portfolio

Performance

'245 - 6.5 ns max t_{pd}
 I_{ccz} - 20 μA max

Packaging

- SOIC
- SSOP
- TSSOP
- Widebus™
- Shrink Widebus™

Widebus & Shrink Widebus are trademarks of Texas Instruments Incorporated



Low Voltage - LV

Circuit Features

- Gates Available
- 8/8 mA Drive - Bus Interface
- 6/6 mA Drive - Gates
- Spec'd for 3.3V and 5V Operation

Advantages

- Similar in Performance to 5V HCMOS
- Marketing & Applications Support
- SPICE Models
- Internal & External 2nd Sources

Performance

- '245 - 14.5 ns max t_{pd}
- I_{ccz} - 20 μ A max

Packaging

- SOIC
- SSOP
- TSSOP



Advanced Low Voltage CMOS - ALVC

Circuit Features

- Bus Hold ($I_{I(HOLD)}$)
- Drive Capability
 - (-24/24 mA @ 3.3V V_{CC})
 - (-6 /12 mA @ 2.5V V_{CC})
- Low Noise
- Damping Resistor Options
- ESD Protection
- Spec'd for 3.3V and 2.5V Operation

Advantages

- Performance Leadership Product
- Marketing & Applications Support
- SPICE Models
- Internal & External 2nd Sources
- Wide Product Portfolio
- Specialized Memory Interface
- Functions Available for SDRAMs

Performance

'16245 - 3.6 ns max t_{pd} (3.3 V_{CC})

Low Power - 40 μA

Packaging

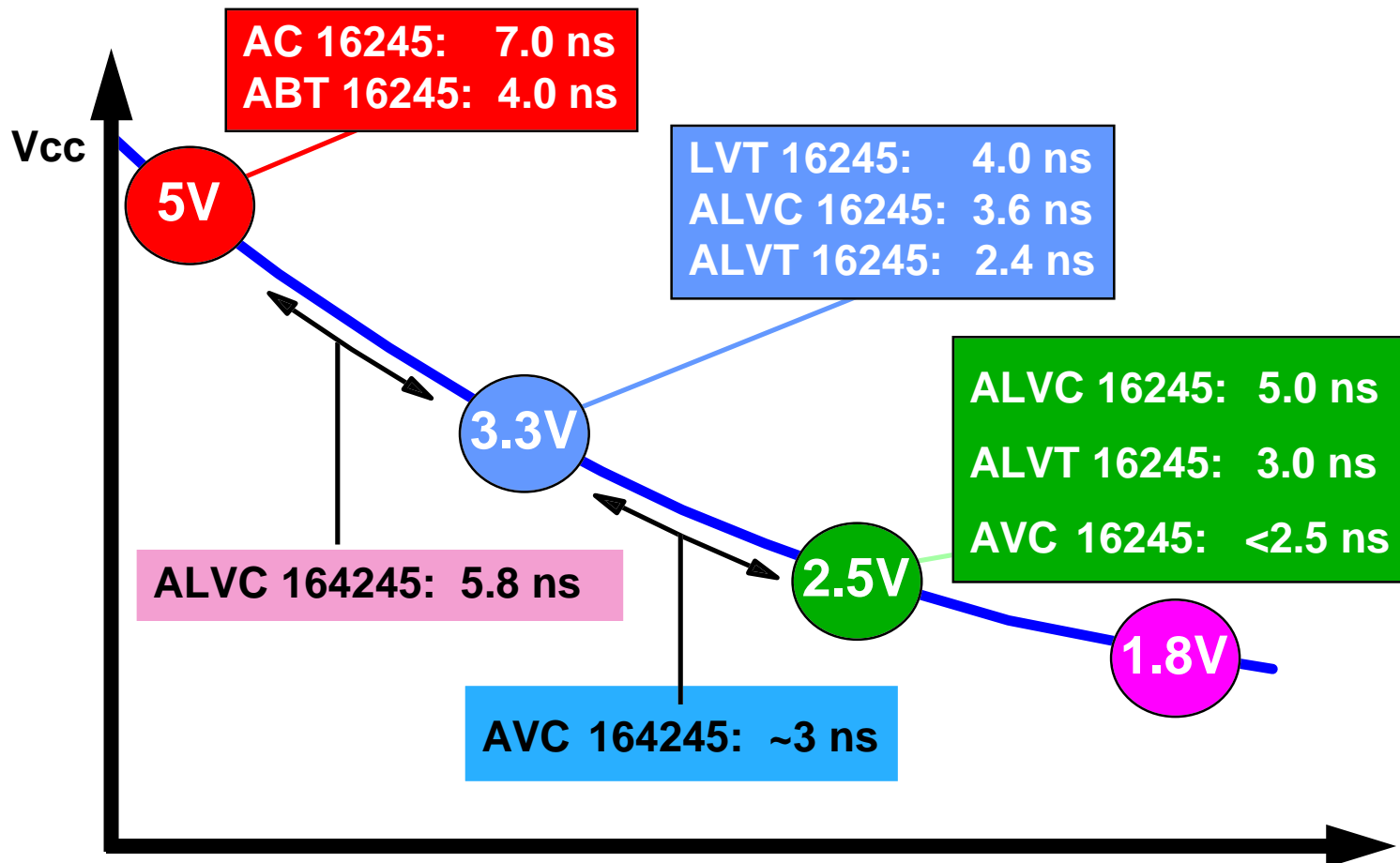
Widebus™

Shrink Widebus™

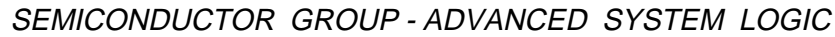
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TI Logic Support Migration to Lower Voltages



- ♦ ALVC and ALVT are specified for both 3.3V and 2.5V operation
- ♦ AVC is designed for dedicated 2.5V operation. Sampling starts in 1Q97



10KΩ Pullup Resistor

16 Bit x 4

320Cxx

X64

ABT16245

ABT16245

ABT16245

ABT16245

BACKPLANE

X64

DS X 6

DS X 6

ABT16245

ABT16245

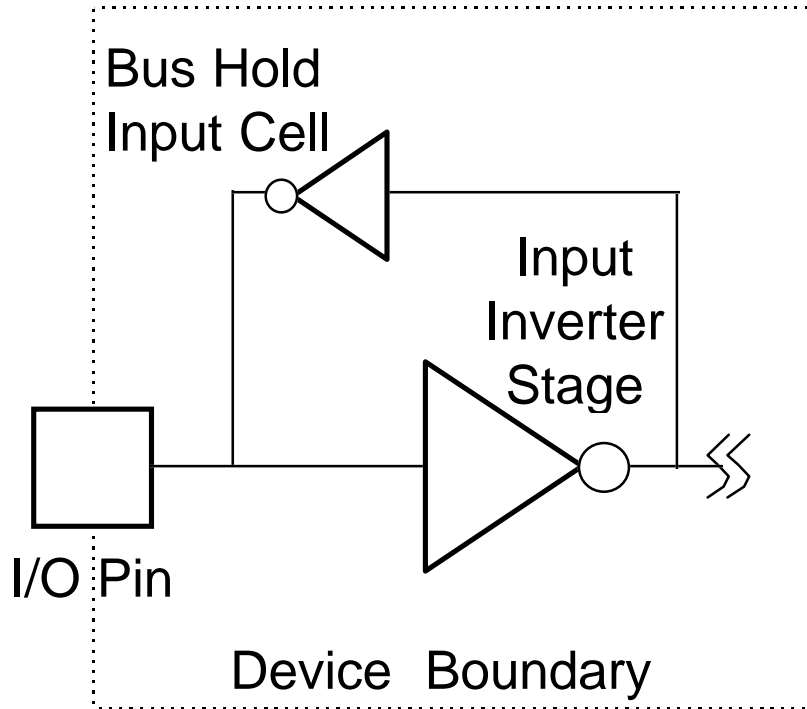
ABT16245

ABT16245

- 33



Bus Hold Input Characteristics



Bus hold input cell
replaces pullup resistor

- Holds the last known state of the input
- Eliminates the need for external resistors on unused or floating input/output pins



Logic With Bus Hold

- ABTH - 12 devices with bus hold.
- LVT - All LVT devices have bus hold.
Name change to LVTH in progress.
- LVCH - 14 devices with bus hold.
- ALVCH - All devices have bus hold
(>40 devices).
- AHCH/AHCTH - Bus hold planned on Widebus devices.



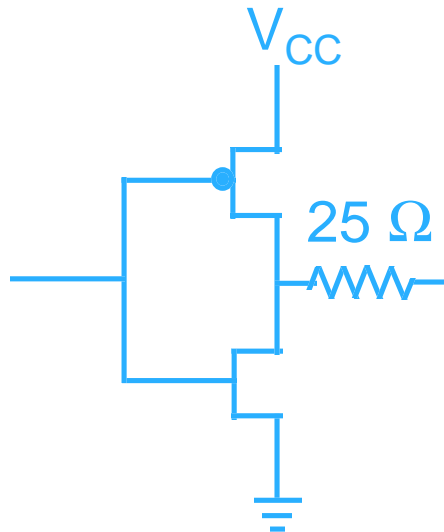
Damping Resistors

- WHY:
1. Damping resistors limit current thereby reducing noise from undershoot / overshoot
 2. Help in line termination (reduces ringing / line reflection to improve signal quality)

eg: ABT2245  Extra "2" in device name
 ABT162245  indicates damping resistor

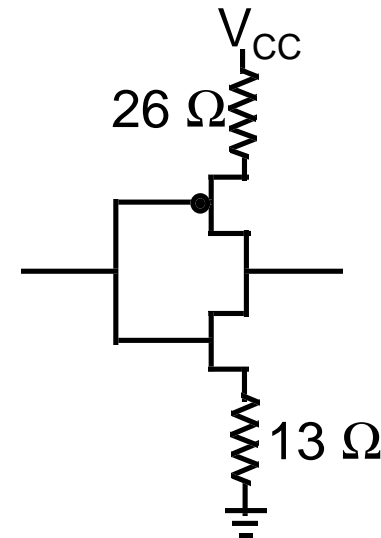


TI Damping Resistor vs. Balanced Drive



TI's placement of the series damping resistor meets both goals:

- ✦ *Limit current*
- ✦ *Help in line termination*



IDT's placement effectively reduces current only. This is not the method preferred for line termination.



Logic with Series Damping Resistors

***ABT:* 18 Devices**

***LVT:* 5 Devices**

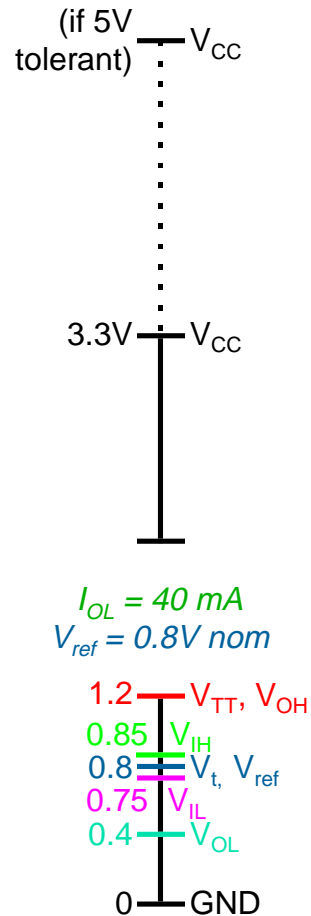
***LVC:* 5 Devices**

***ALVC:* 21 Devices**

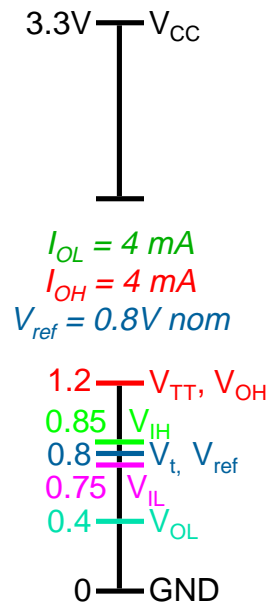


IC Basics

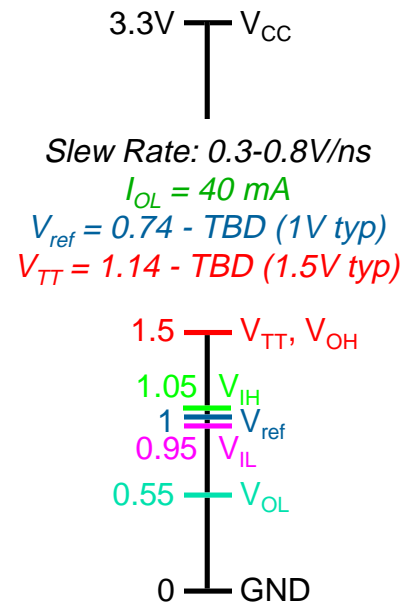
Comparison of Backplane Switching Standards



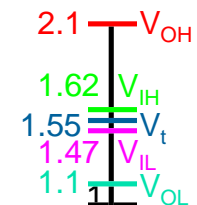
GTL
Terminated Case



GTL
Unterminated Case



GTL+

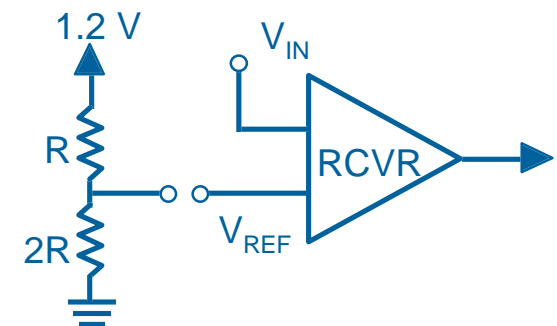
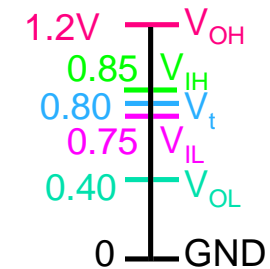
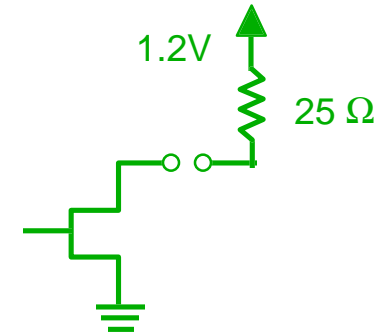


BTL/FB+



What is GTL?

- Driver is an open drain n-channel CMOS transistor
- Reduced voltage swing reduces power and allows integration into VLSI CMOS
- Receiver stage is a differential input with external V_{REF} set at 0.8V. V_{REF} is derived from simple R/2R voltage divider of 1.2V pull-up.





Advantages of GTL

Noise: External V_{REF} provides common-mode noise immunity (derived from 1.2V pull-up).
Low signal amplitude reduces EMI

Speed: Absence of Reflections Allows Higher System Clock Rate
- Very high speed point-to-point communication (100+ MHz)
- Backplane speeds over 60 MHz

Power: High speed, low power backplane alternative to BTL or ECL

Power Comparison (160 active I/Os)

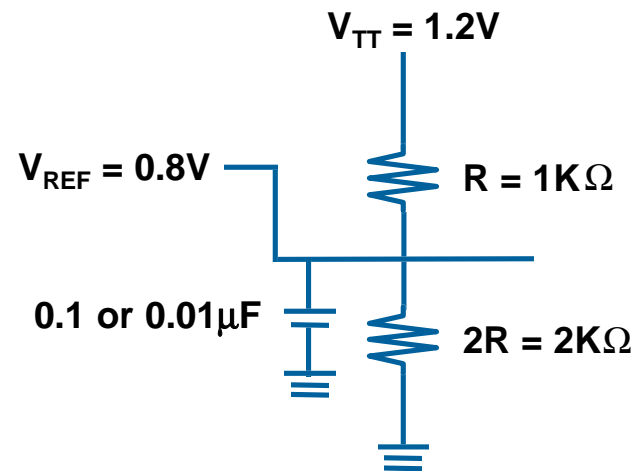
<u>Technology</u>	<u>Power (watts)</u>	<u>Termination</u>
ECL 10K	20	25 Ω to 3.0V
BTL	11	16.5 Ω to 2.0V
GTL	1.5	50 Ω to 1.2V

Cost: GTL transceivers are less than half the cost per bit as BTL drivers of comparable speeds.



Design Considerations

- V_{TT} (1.2/1.5V) must be regulated from V_{CC}
- V_{REF} must be generated from (1.2/1.5V) V_{TT}
- Add bypass capacitors to regulate the 0.8V V_{REF}

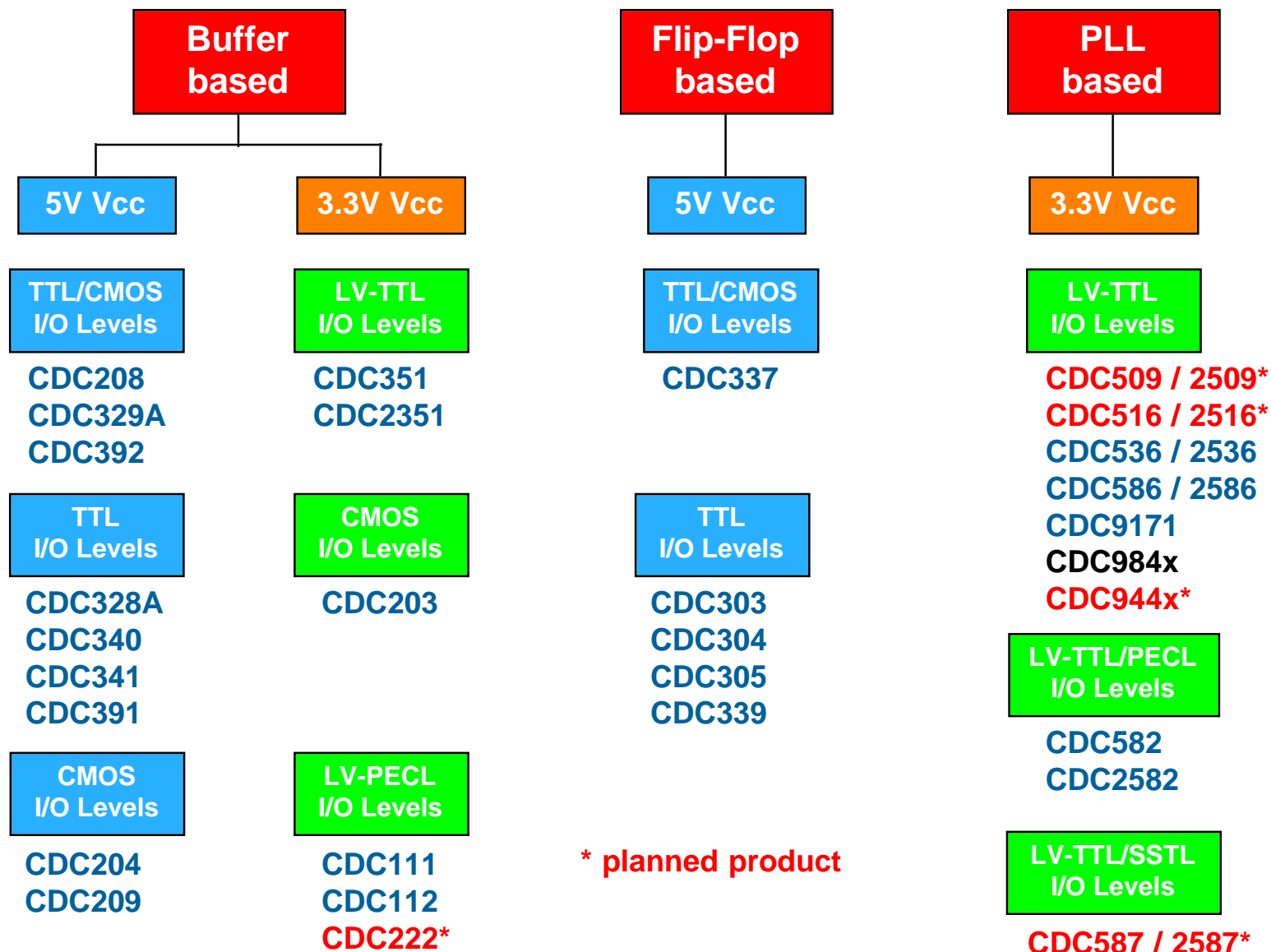


- Need both $3.3V_{CC}$ and $5V_{CC}$ power supply on the 'GTL16612

Linear Technology makes some regulators
5 - 1.2V LT1086 2 amps



Clock Distribution Circuits





Clock Distribution Circuits

Product Focus Areas

Work-stations

CDC111
CDC112
CDC222*
CDC509 / 2509*
CDC516 / 2516*
CDC536 / 2536
CDC582 / 2582
CDC586 / 2586

Personal Computers

CDC351 / 2351
CDC586 / 2586
CDC984x
CDC9441*
CDC9442*
CDC9449*

Memory Modules

CDC509 / 2509*
CDC516 / 2516*
CDC536 / 2536
CDC586 / 2586
CDC587 / 2587*

Digital Video Disk

CDC9171
CDC917x*

* planned product

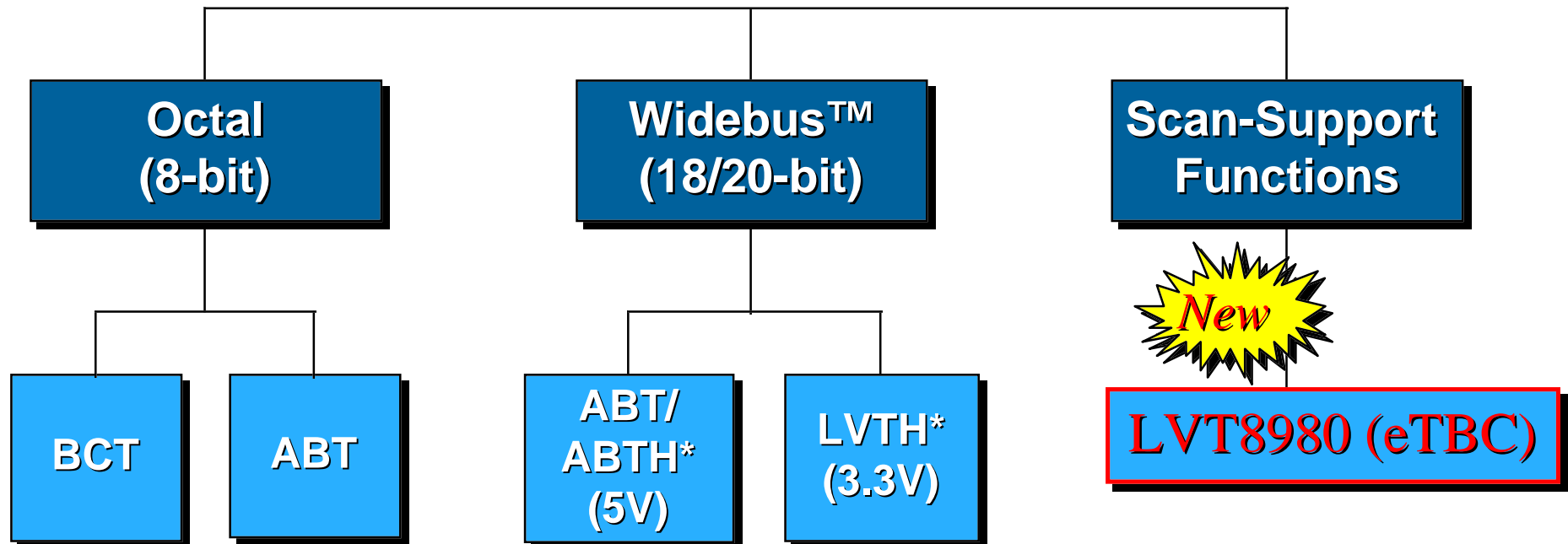
Other general-purpose CDC buffers and flip-flops support variety of applications in PC/Workstation, Telecom/Internetworking and Industrial end equipments



What Does TI Offer in IEEE 1149.1 (JTAG) Silicon Solutions?

30+ commercially released devices

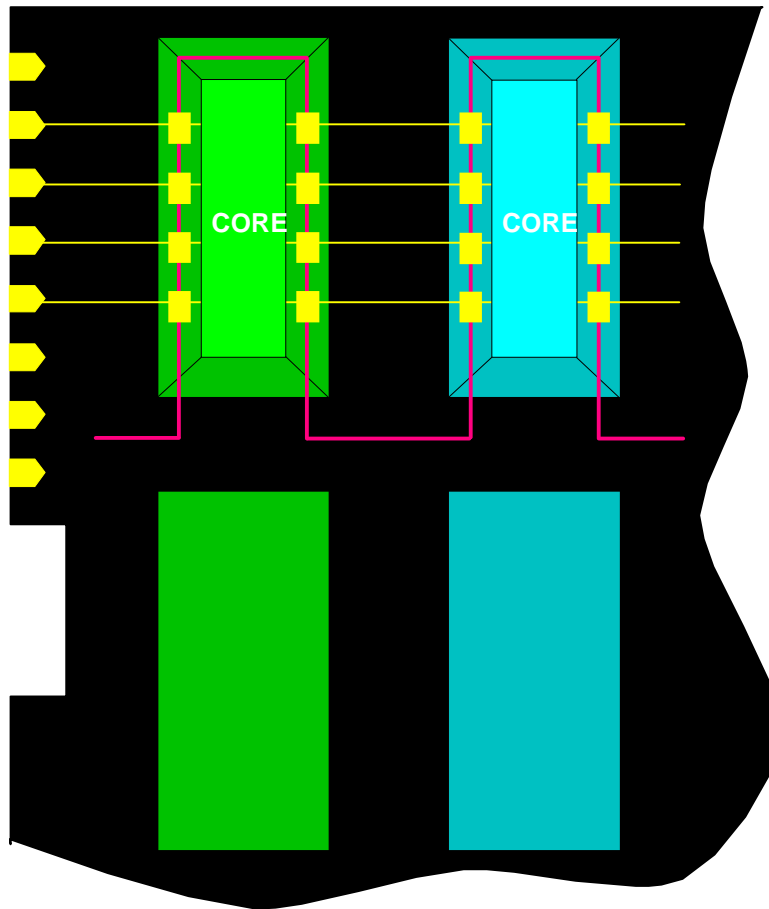
IEEE 1149.1 (JTAG) Boundary-Scan Logic Devices



* Bus Hold option



The Boundary Scan Idea



- Scan provides a means to arbitrarily observe test results and source test stimulus
- Scan method requires minimal on chip/board resources (pins/nets)



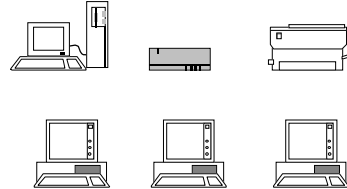
SEMICONDUCTOR GROUP - ADVANCED SYSTEM LOGIC

End Equipment Designing with JTAG Boundary-Scan



Telecom

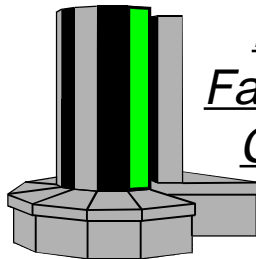
Networking



Mid-Range
'Server'
Computers



High End
Fault Tolerant'
Computers

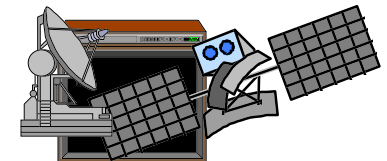
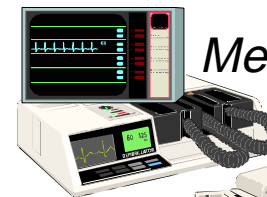


Military



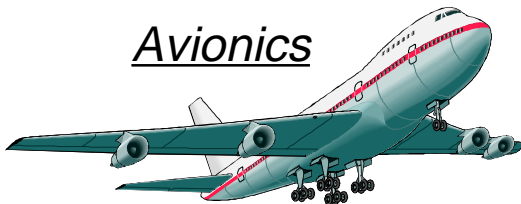
Imaging Systems

Medical



Conferencing

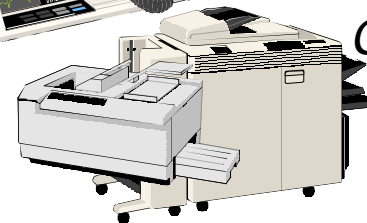
Avionics



Consumer

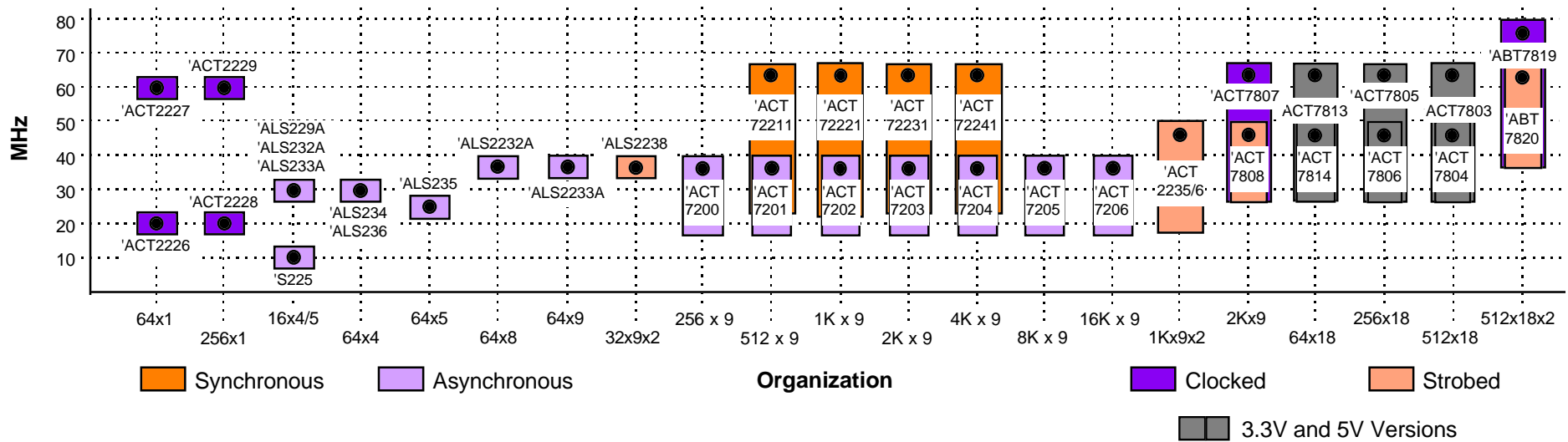


Copiers

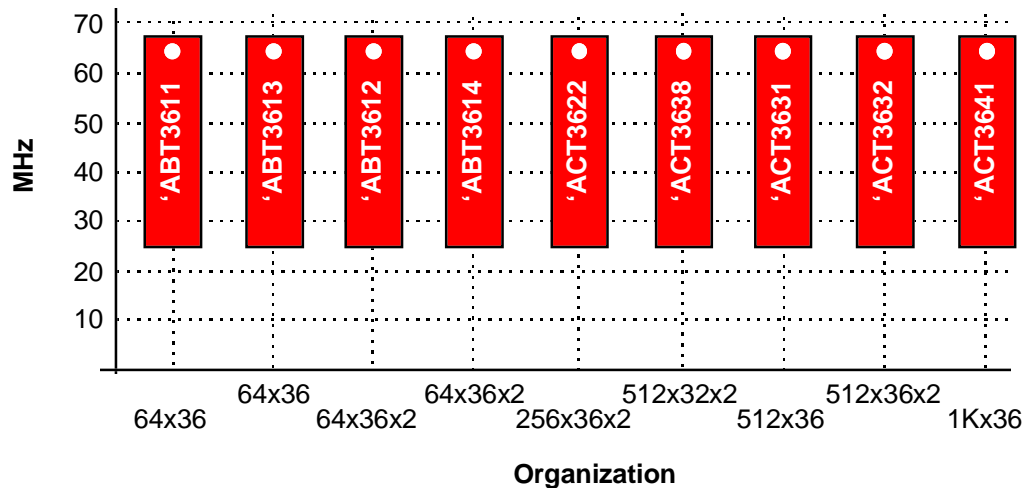




FIFO Product Portfolio



ADVANCED FIFOs



- Multiple Speed Sorts
- Unidirectional and Bidirectional
- Advanced Fine-Pitch Packaging