

Welcome!

Texas Instruments New Product Update

- This webinar will be recorded and available at www.ti.com/npu
- Phone lines will be muted
- Please post questions in the chat or contact your sales person or field applications engineer

New Product Update: High speed comparator

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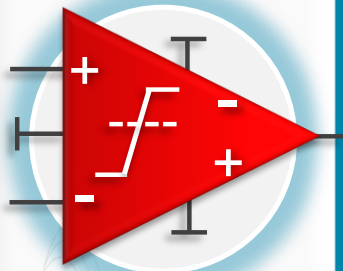
April 15th, 2021

Agenda

- TI comparator portfolio
- 800-ps propagation delay comparator with LVDS output
 - TLV3604, TLV3605
- Application examples
 - Signal and clock restoration
 - Pulse detection
 - Signal triggering function
- Other circuit improvements
- Key online design resources

Comparator portfolio

Supplying comparators for over 50 Years: **Robust** and **flexible** without compromise



Comparator portfolio

> 150 devices
> 4000 customers
> 100 end equipments

TI Designs



Low power



Low power comparators

<10uA comparators

Over 70 devices



- Smallest packages down to 0.7mm x 0.7mm
- Integrated Reference with high accuracy
- Extremely low power



High voltage



Wide vin comparators

Up to 40 V

Next generation up to 65V

Over 80 devices



- Wide supply operation
- Leaded and leadless Packages
- Integrated reference
- Combination amp/comp
- Automotive qualified



High speed



High speed comparators

<= 100ns

Over 30 devices



- 100+MHz toggle rates
- Fast response time
- Push-pull and LVDS output options



TI's key high speed comparator portfolio

AEC Q100

Q100 planned

Comparators	High Speed 10 ~ 100nS	<div>LMV7235/9</div> <div>75ns push-pull, 65uA IQ 2.7 to 5.5V supply 1 channel</div>	<div>Q100</div> <div>TLV3201/2</div> <div>40ns Push-Pull, 40uA IQ 2.7 to 5.5V supply 1 and 2 channel</div>	<div>Q100</div> <div>TLV9032/22/34/24</div> <div>100ns PP/OD, 15uA IQ 1.65 to 5.5V Supply 2 and 4 channel</div>
	1 ~ 10nS	<div>LMV7219</div> <div>7ns push-pull, 1mA IQ 2.7~5V supply 1 channel</div>	<div>Q100</div> <div>TLV3501/2</div> <div>4.5ns push-pull, 3.2mA IQ 2.7 to 5.5V usply 1/2 channel</div>	
	< 1nS		<div>LMH7322/4</div> <div>700 ps RSPECL, 22.8 mA IQ 2.7~12V supply 2/4-channel</div>	<div>Q100 planned</div> <div>TLV3604/5</div> <div>800 ps LVDS, 12 mA IQ 2.4 to 5.5V supply 1-channel</div>

TLV3501/2

4.5 ns propagation delay / push-pull (industrial & automotive)

Features

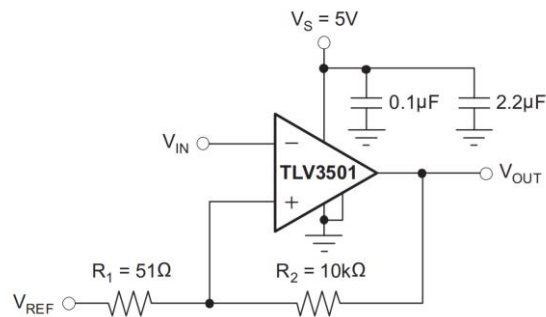
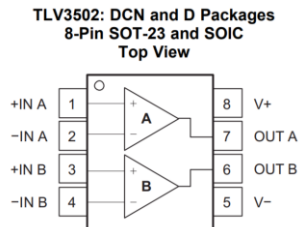
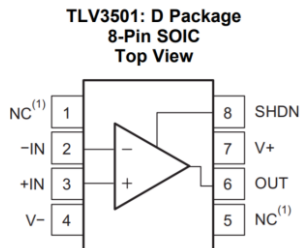
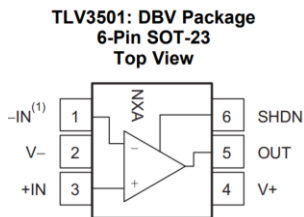
- Fast response time, power efficient
 - Push-Pull : t_{PD} **4.5ns @ 50mV** overdrive
- Supply voltage **2.7 to 5.5 V**
- Rail-to-rail input
- Input offset voltage (max) **6.5 mV**
- Quiescent current **3.2 mA**
- t_{PD} dispersion ($V_{OD}=10 \sim 100mV$) **2 ns**
- Toggle frequency **83MHz**
- Operating temperature range: **-40°C to 125°C**

Applications

- Over voltage/current monitoring
- Laser scanner (Time-of-Flight), e.g. vacuum robot
- High-speed system monitoring
- Low side current sensing

Benefits

- Comparing to differential output structure, single-ended output can save board layout space and number of IOs



TLV3604/5

800 ps propagation delay / LVDS (industrial & automotive)

Features

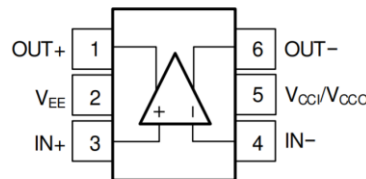
- Fast response time
 - LVDS : t_{PD} **800 ps @ 50mV OverDrive**
- Supply voltage **2.4 to 5.5 V**
- Rail-to-rail input
- Input offset voltage (max) **5 mV**
- Quiescent current **12 mA**
- Minimum pulse width **600 ps**
- t_{PD} dispersion ($V_{OD}=10 \sim 250\text{mV}$) **350 ps**
- Toggle frequency **1.5GHz**
- Operating temperature range: **-40°C to 125°C**

Applications

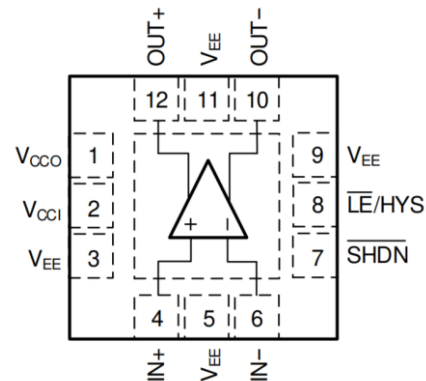
- Clock and data restoration
- Laser scanner (Time-of-Flight)
- Proximity sensor
- Oscilloscope/logic analyzer
- Single peak detection

Benefits

- Suitable for very high speed applications
- LVDS outputs for easy interfacing to FPGA and modern ASIC

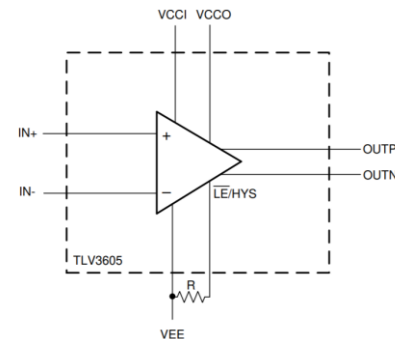
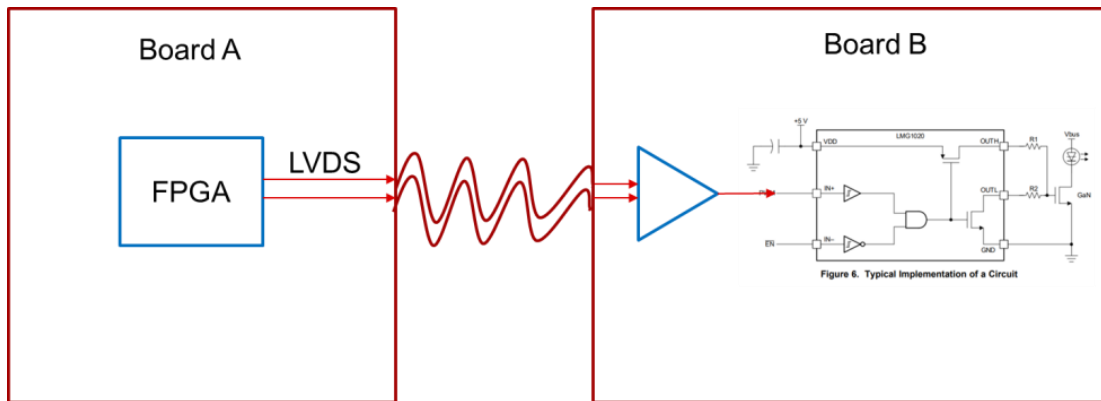


TLV3604



TLV3605

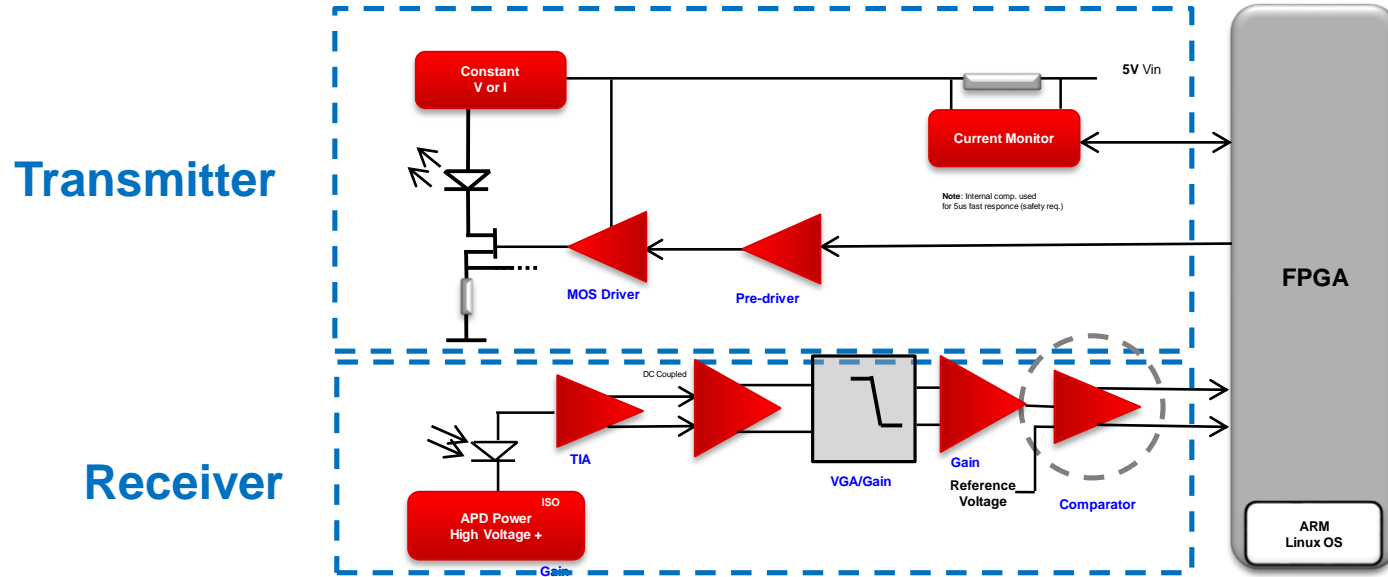
Signal and clock restoration



	LVDS buffer	TLV3604/5
Cost	Low	High
Input sensitivity	Limited to V_{IH}/V_{IL}	High
CMRR	None	High

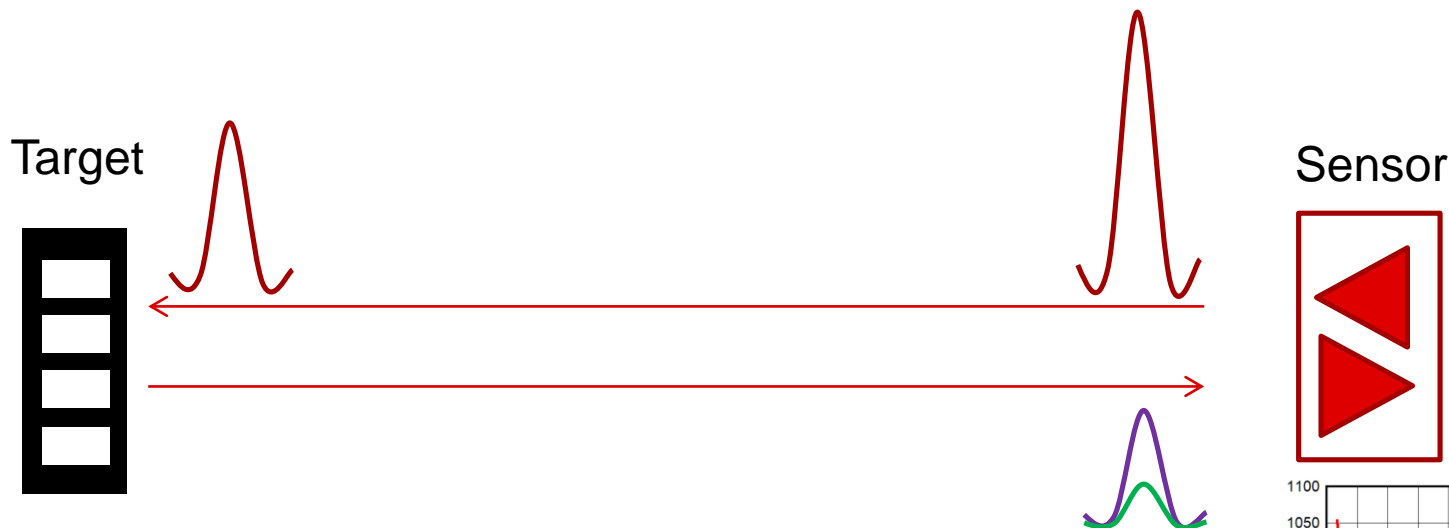
1. TLV3604 TLV3605 benefits long range signal transmission in noisy environment
2. EMI is well suppressed compared to single-ended push-pull output

Time-of-flight application



- Minimum pulse width detection capability determines the detection range
 - TLV3604/5 have 600ps minimum pulse detection capability
- $t_{PD_Dispersion}$, propagation delay's dispersion is crucial
 - TLV3604/5 have 350ps propagation delay dispersion

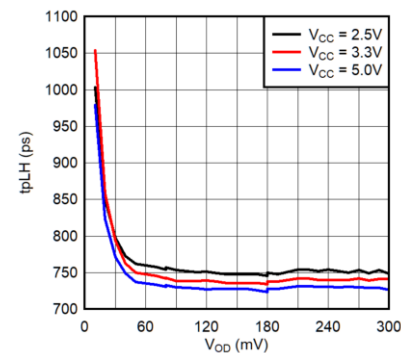
Why t_{PD} overdrive dispersion matters



Distance = speed of light * delay / 2

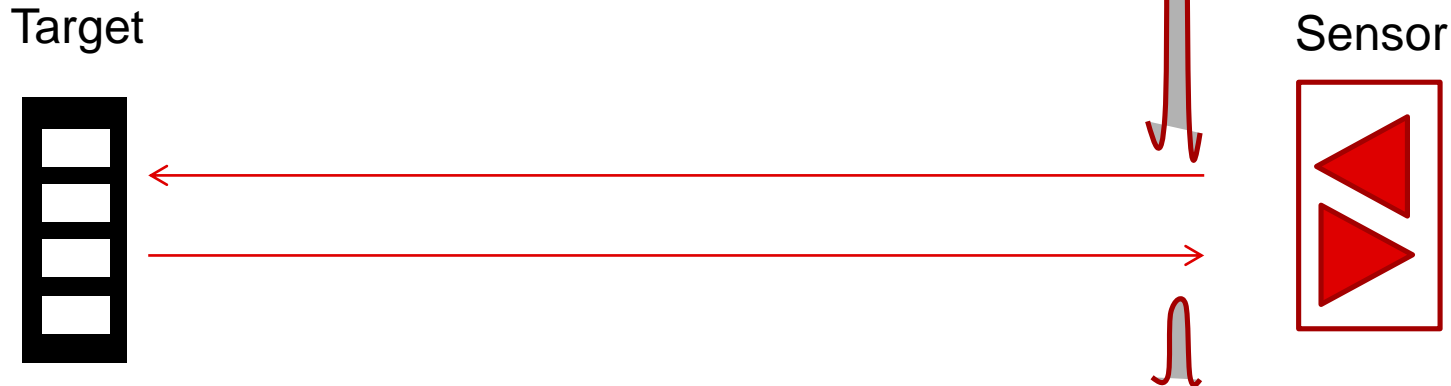
Delay uncertainty comes from the t_{PD} dispersion
(overdrive, temperature, jitter)

TLV3604/5 (350ps overdrive dispersion)



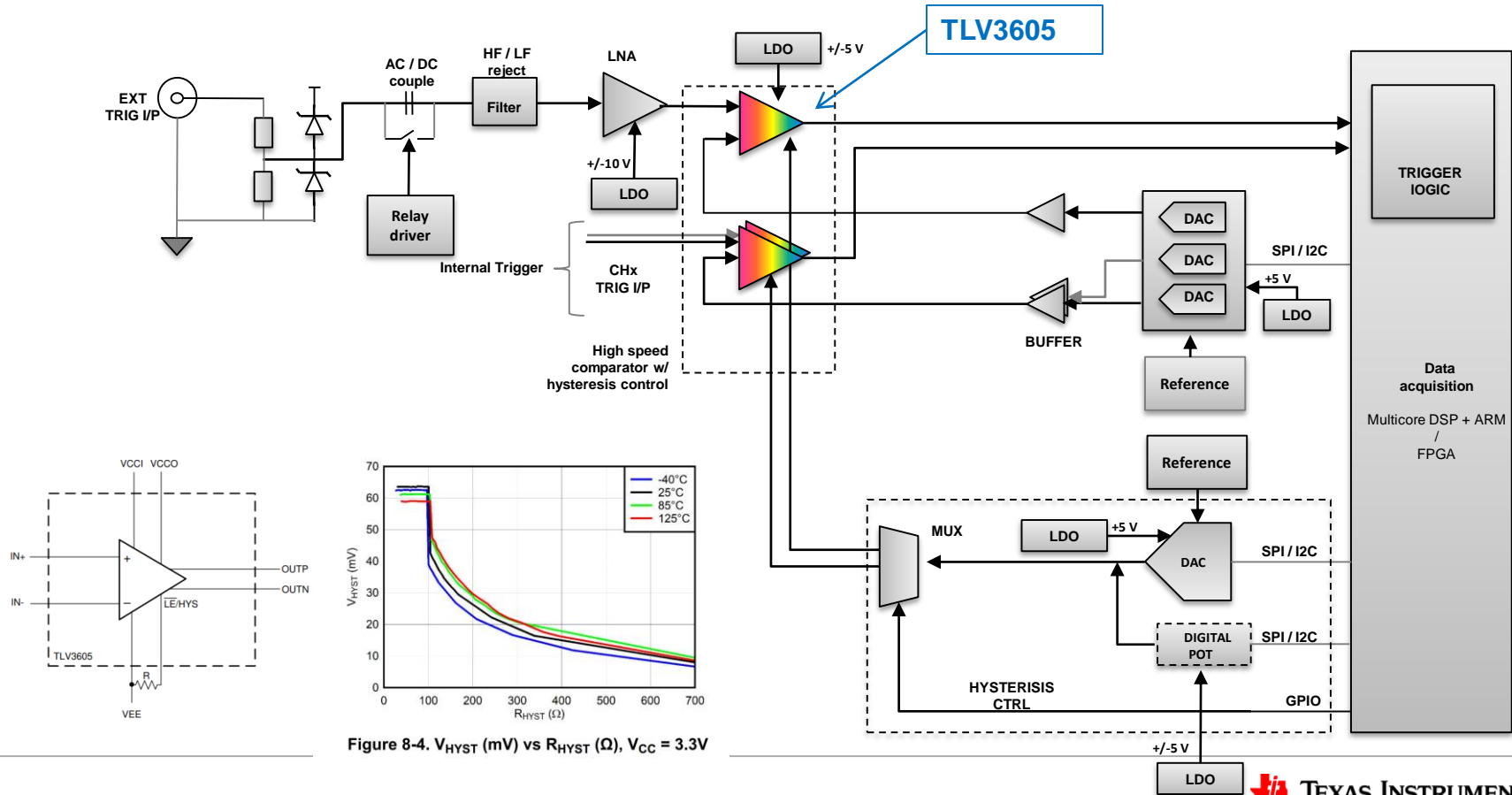
1U

Why minimum pulse width matters



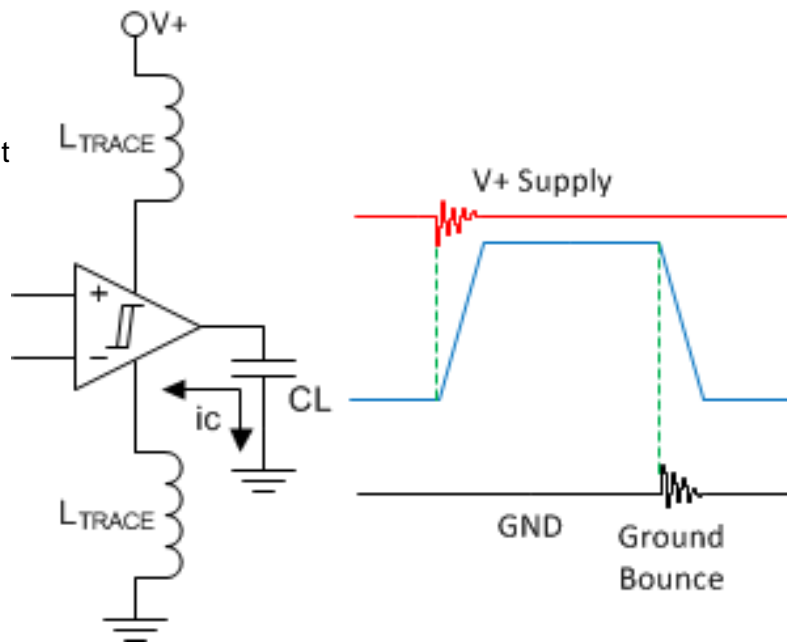
- Extending range by increasing the amplitude of laser
- Industry eye safety standard requires the shade area (energy) should be lower than a threshold
- TLV3604/5 (600ps minimum pulse width detection)

Test & measurement trigger subsystem

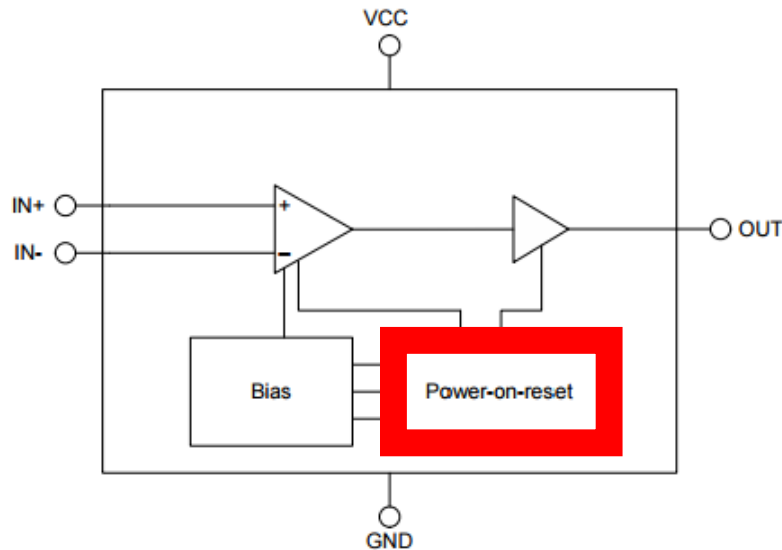


Layout considerations for comparators

- We tend to think of comparators as “slow” devices – they are not!
- Digital outputs actually make them “fast” devices
 - Comparators can have rise/fall times in the 100’s of nanoseconds
 - Peak currents are drawn from the supplies to charge/discharge output capacitance during output transitions (remember: $i = C * (\Delta v / \Delta t)$!)
 - Peak currents (>50mA!) can cause poorly bypassed supplies to ring
 - Poor layout can cause grounds to ring
 - Ground bounce can cause input signals to shift
 - **Major cause of oscillations, EMI and false triggering**
- Treat comparators like a “fast” digital gate – even if input signal is slow.
 - Bypass cap across supply pins (0.1uF ceramic)
 - Use Short, direct ground traces
 - Use proper output terminations and traces for high speed (<200ns) devices
 - Use multiple caps, separated by two decades to minimize resonance (1nF and 100nF)



Internal power-on-reset (POR)



TI new comparator's generic block diagram

TLV3604/5 output remains high-Z during power up

Key online resources

- [TLV3604 product page](#)
- [TLV3605 product page](#)
- [Cookbook circuitry](#)
- [POR FAQ on E2E](#)
- [Distance measurement with high speed comparators in optical ToF applications \(AppNote\)](#)
- [Intro to high speed comparators: ToF distance measurements with LVDS comparator \(Video\)](#)

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