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200 MHz Dual Integrated DCL with Level Setting DACs, Per Pin PMU, and Per Chip VHH

Data Sheet

ADATE304

FEATURES

Driver
- **3-level driver with high-Z mode and built-in clamps**
- **Precision trimmed output resistance**
- **Low leakage mode (typically <10 nA)**
- **Voltage range: up to −2.0 V to +6.0 V**
- **2.4 ns minimum pulse width, 2 V terminated**

Comparator
- **Window and differential comparator**
- **500 MHz input equivalent bandwidth**

Load
- **±12 mA maximum current capability**

Per pin PMU
- **Force voltage range: up to −2.0 V to +6.0 V**
- **5 current ranges: 32 mA, 2 mA, 200 µA, 20 µA, 2 µA**

Levels
- **14-bit DAC for DCL levels**
- **Typically < ±5 mV INL (calibrated)**
- **16-bit DAC for PMU levels**
- **Typically < ±1.5 mV INL (calibrated) linearity in FV mode**

HVOUT output buffer
- **0 V to 13.5 V output range**

84-lead, 9 mm × 9 mm, CSP_BGA package

900 mW per channel with no load

APPLICATIONS

Automatic test equipment

Semiconductor test systems

Board test systems

Instrumentation and characterization equipment

GENERAL DESCRIPTION

The ADATE304 is a complete, single-chip solution that performs the pin electronic functions of the driver, the comparator, and the active load (DCL), per pin PMU, and dc levels for ATE applications. The device also contains an HVOUT driver with a VHH buffer capable of generating up to 13.5 V.

The driver features three active states: data high mode, data low mode, and term mode, as well as an inhibit state. The inhibit state, in conjunction with the integrated dynamic clamp, facilitates the implementation of a high speed active termination. The ADATE304 supports two output voltage ranges: −2.0 V to +6.0 V and −1.25 V to +6.75 V by adjusting the positive and negative supply voltages.

Each channel of the ADATE304 features a high speed window comparator per pin for functional testing, as well as a per pin PMU with FV, or FI and MV, or MI functions. All necessary dc levels for DCL functions are generated by on-chip 14-bit DACs. The per pin PMU features an on-chip 16-bit DAC for high accuracy and contains integrated range resistors to minimize external component counts.

The ADATE304 uses a serial bus to program all functional blocks and has an on-board temperature sensor for monitoring the device temperature.

Rev. A

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REVISION HISTORY

4/2017—Rev. 0 to Rev. A

Changes to Power Supplies Parameter, Table 1 ... 4

10/2008—Revision 0: Initial Version

FUNCTIONAL BLOCK DIAGRAM

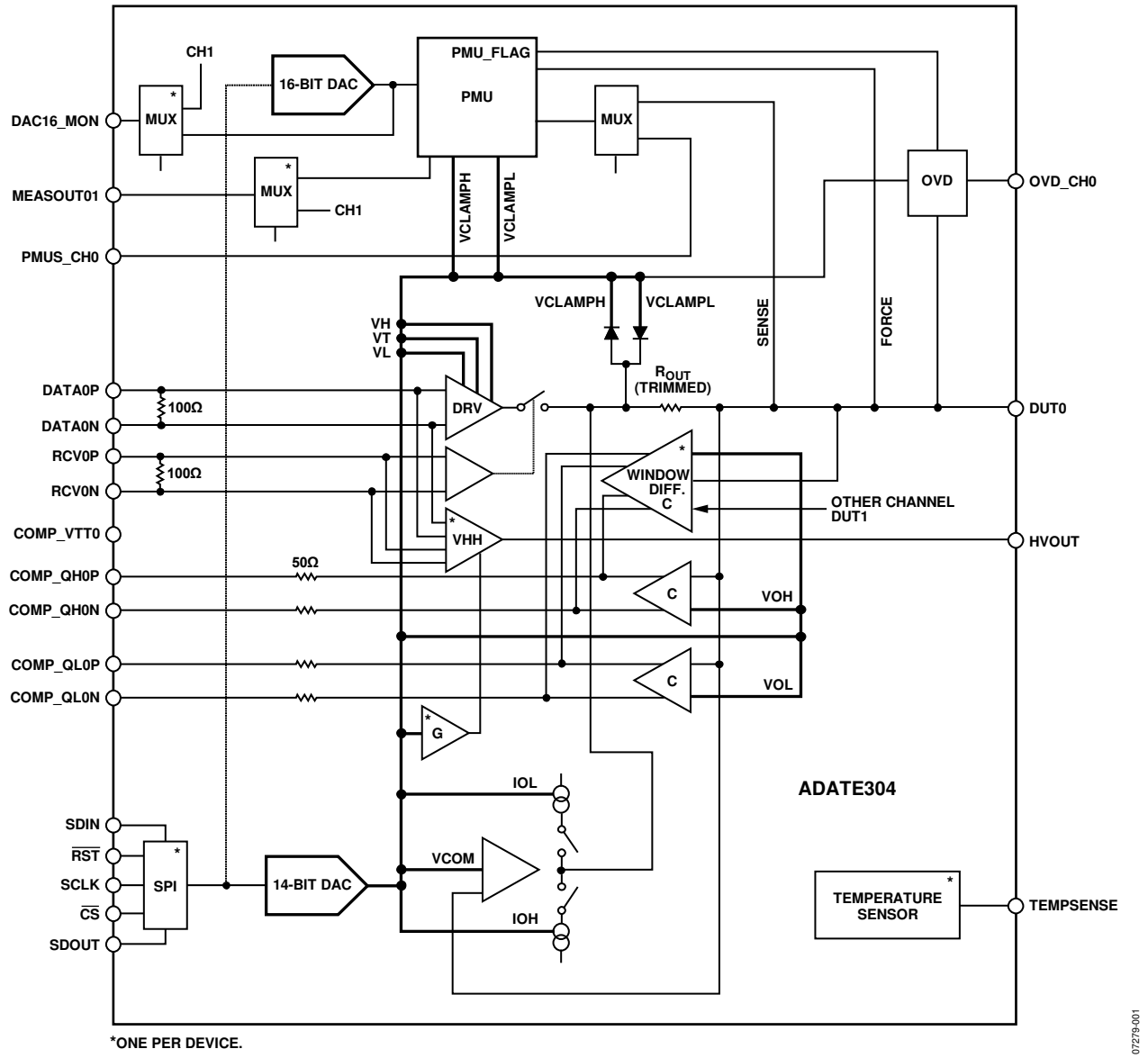

Figure 1. One of Two Channels

SPECIFICATIONS

Characterization and production tests performed using Power Supply Range 1 (see Table 37). V_{DD} = +10.75 V, V_{CC} = +3.3 V, V_{SS} = −5.00 V, V_{PLUS} = +16.75 V, V_{COMP_VTT} = +3.3 V, V_{REF} = +5.0 V, V_{REF_GND} = 0.0 V. All default test conditions are as defined in Table 38. All specified values are at T_J = 55°C, where T_J corresponds to the internal temperature sensor and the temperature coefficients are measured at T_J = 55°C ± 20°C, unless otherwise noted. Typical values are based on design, simulation analyses, and/or limited bench evaluations. Typical values are not tested or guaranteed. Test levels are specified in the Explanation of Test Levels section.

TOTAL FUNCTION

Table 1.

Parameter	Symbol	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
TOTAL FUNCTION							
Output Leakage Current							
PE Disable Range E		−20.0	+5.3	+20.0	nA	P	−1.25 V < V_{DUTx} < +6.0 V; PMU and PE disabled via SPI; PMU Range E, VCH = 7.0 V, VCL = −2.5 V
PE Disable Range A to Range D			5.3		nA	C_T	−1.25 V < V_{DUTx} < +6.0 V; PMU and PE disabled via SPI; PMU Range A, PMU Range B, PMU Range C, and PMU Range D, VCH = +7.0 V, VCL = −2.5 V
High-Z Mode		−400	+5.4	+400	nA	P	−1.25 V < V_{DUTx} < +6.0 V; PMU disabled and PE enabled via SPI; RCV active, VCH = +7.0 V, VCL = −2.5 V
Output Capacitance			4		pF	S	VTERM mode operation
DUT Pin Range		−1.25		+6.0	V	D	
POWER SUPPLIES							
Total Supply Range, V_{PLUS} to V_{SS}			22.5	23.25	V	D	Defines PSRR conditions
VPLUS Supply	V_{PLUS}	16.25	16.75	17.25	V	D	Defines PSRR conditions
Positive Supply	V_{DD}	10.25	10.75	11.25	V	D	Defines PSRR conditions
Negative Supply	V_{SS}	−5.25	−5.00	−4.75	V	D	Defines PSRR conditions
Logic Supply	V_{CC}	3.1	3.3	3.5	V	D	Defines PSRR conditions
Comparator Termination	V_{COMP_VTT}	3.3		5.0	V	D	
V_{PLUS} Supply Current	I_{PLUS}	−1.0	+1.3	+3.0	mA	P	HVOUT disabled
		4.0	12.7	16.0	mA	P	HVOUT enabled, RCV active, no load, VHH = 12 V
Logic Supply Current	I_{CC}	1.0	2.7	4.0	mA	P	Quiescent (SPI is static)
Comparator Termination Current	I_{COMP_VTT}	10.0	17	26.0	mA	P	
Positive Supply Current	I_{DD}	72	94	106	mA	P	Load power down (IOH = IOL = 0 mA)
Negative Supply Current	I_{SS}	100	118	135	mA	P	Load power down (IOH = IOL = 0 mA)
Total Power Dissipation		1.0	1.68	1.96	W	P	Load power down (IOH = IOL = 0 mA)
Positive Supply Current	I_{DD}	102	134	161	mA	P	Load active off (IOH = IOL = 12 mA)
Negative Supply Current	I_{SS}	130	155	190	mA	P	Load active off (IOH = IOL = 12 mA)
Total Power Dissipation		1.8	2.3	2.64	W	P	Load active off (IOH = IOL = 12 mA)
TEMPERATURE MONITORS							
Temperature Sensor Gain			10		mV/K	C_T	
Temperature Sensor Accuracy Without Calibration over 25°C to 100°C			6		°C	C_T	Temperature voltage available on Pin A1 at all times and on Pin K1 (MEASOUT01/TEMPSENSE) when selected (see Table 24 and Table 36)
VREF INPUT							
Reference Input Voltage Range for DACs (VREF Pin)		4.95	5	5.05	V	D	Referenced to V_{REF_GND}; not referenced to V_{DUTGND}
Input Bias Current			0.1	100	µA	P	Tested with 5 V applied

DRIVER

VH − VL ≥ 200 mV (to meet dc and ac specifications).

Table 2.

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
DC SPECIFICATIONS						
High Speed Differential Logic Input Characteristics (DATAxx, RCVxx)						
Input Termination Resistance	92	100	108	Ω	P	Push 6 mA into xP pins[1], force 1.3 V on xN pins[1]; measure voltage from xP to xN[1], calculate resistance (ΔV/ΔI)
Input Voltage Differential	0.2		1.0	V	P_F	
Common-Mode Voltage	0.85		2.35	V	P_F	
	0.85		3.5	V	D	
Input Bias Current	−20.0	+2.2	+20.0	µA	P	Each pin tested at 2.85 V and 0.35 V while the other high speed pin remains open
Pin Output Characteristics						
Output High Range, VH	−1.15		+6.75	V	D	
Output Low Range, VL	−1.25		+6.65	V	D	
Output Term Range, VT	−1.25		+6.75	V	D	
Functional Amplitude (VH − VL)	0.0	8.0		V	D	Amplitude can be programmed to VH = VL, accuracy specifications apply when VH − VL ≥ 200 mV
DC Output Current Limit Source	75	100	120	mA	P	Driver high, VH = 6.75 V, short DUTx pin to −1.25 V, measure current
DC Output Current Limit Sink	−120	−100	−75	mA	P	Driver low, VL = −1.25 V, short DUTx pin to +6.75 V, measure current
Output Resistance, ±50 mA	45.0	47.0	49.0	Ω	P	Source: driver high, VH = +3.0 V, I_{DUTx} = +1 mA and +50 mA; sink: driver low, VL = 0.0 V, I_{DUTx} = −1 mA and −50 mA; $\Delta V_{DUT}/\Delta I_{DUT}$
ABSOLUTE ACCURACY						VH tests done with VL = −2.5 V and VT= −2.5 V; VL tests done with VH = +7.5 V and VT = +7.5 V; VT tests done with VL = −2.5 V and VH = +7.5 V; unless otherwise specified
VH, VL, VT Uncalibrated Accuracy	−250	±75	+250	mV	P	Error measured at calibration points of 0 V and 5 V
VH, VL, VT Offset Tempco		±450		µV/°C	C_T	Measured at calibration points
VH, VL, VT DNL		±1		mV	C_T	After two-point gain/offset calibration
VH, VL, VT INL	−10	±2.5	+10	mV	P	After two-point gain/offset calibration; measured over driver output ranges
VH, VL, VT Resolution		0.6	+1	mV	P_F	After two-point gain/offset calibration; range/number of DAC bits as measured at calibration points of 0 V and 5 V
DUTGND Voltage Accuracy	−7	±1.3	+7	mV	P	Over ±0.1 V range; measured at endpoints of VH, VL, and VT functional range
VH, VL, VT Crosstalk		±2		mV	C_T	VL = −1.25 V: VH = −1.15 V → +6.75 V, VT = −1.25 V → +6.75 V; VH = +6.75 V: VL = −1.25 V → +6.65 V, VT = −1.25 V → +6.75 V; VT = +1.25 V: VL = −1.25 V → +6.65 V, VH = −1.15 V → +6.75 V; dc crosstalk on VL, VH, VT output level when other driver DACs are varied
Overall Voltage Accuracy		±10		mV	C_T	Sum of INL, crosstalk, DUTGND, and tempco over ±5°C, after gain/offset calibration
VH, VL, VT DC PSRR		±15		mV/V	C_T	Measured at calibration points
AC SPECIFICATIONS						
Rise/Fall Times						Toggle DATAxx
0.2 V Programmed Swing		950		ps	C_B	VH = 0.2 V, VL = 0.0 V, terminated; 20% to 80%
1.0 V Programmed Swing		850		ps	C_B	VH = 1.0 V, VL = 0.0 V, terminated; 20% to 80%
2.0 V Programmed Swing	850	1150	1350	ps	C_B	VH = 3.0 V, VL = 0.0 V, terminated; 20% to 80%
3.0 V Programmed Swing		1500		ps	P/C_B	VH = 3.0 V, VL = 0.0 V, terminated; 20% to 80%
3.0 V Programmed Swing		2000		ps	C_B	VH = 3.0 V, VL = 0.0 V, unterminated; 10% to 90%
5.0 V Programmed Swing		3100		ps	C_B	VH = 5.0V, VL = 0.0 V, unterminated; 10% to 90%
Rise-to-Fall Matching		40		ps	C_B	VH = 3.0 V, VL = 0.0 V, terminated; rise-to-fall within one channel

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
Minimum Pulse Width						Toggle DATAxx
1.0 V Programmed Swing		1.7		ns	C_B	VH = 1.0 V, VL = 0.0 V, terminated; timing error ± 75 ps
		1.7		ns	C_B	VH = 1.0 V, VL = 0.0 V, terminated; less than 10% amplitude degradation
2.0 V Programmed Swing		2.0		ns	C_B	VH = 2.0 V, VL = 0.0 V, terminated; timing error ± 75 ps
		2.2		ns	C_B	VH = 2.0 V, VL = 0.0 V, terminated; less than 10% amplitude degradation
3.0 V Programmed Swing		2.7		ns	C_B	VH = 3.0 V, VL = 0.0 V, terminated; timing error ± 75 ps
		2.7		ns	C_B	VH = 3.0 V, VL = 0.0 V, terminated; less than 10% amplitude degradation
Maximum Toggle Rate						
2.0 V Programmed Swing		200		MHz	C_B	VH = 2.0 V, VH = 0.0 V, terminated, 10% amplitude degradation
Dynamic Performance, Drive (VH to VL and VL to VH)						Toggle DATAxx
Propagation Delay Time		3.0		ns	C_B	VH = 2.0 V, VL = 0.0 V, terminated
Propagation Delay Tempco		3.0		ps/°C	C_T	VH = 2.0 V, VL = 0.0 V, terminated
Delay Matching						VH = 2.0 V, VL = 0.0 V, terminated
Edge to Edge		80		ps	C_B	Rising vs. falling
Channel to Channel		30		ps	C_B	Rising vs. rising, falling vs. falling
Delay Change vs. Duty Cycle		30		ps	C_B	VH = 3.0 V, VL = 0.0 V, terminated; 5% to 95% duty cycle; 1 MHz
Overshoot and Undershoot		30		mV	C_B	VH = 3.0 V, VL = 0.0 V, terminated
Settling Time (VH to VL)						Toggle DATAxx
To Within 3% of Final Value		4		ns	C_B	VH = 3.0 V, VL = 0.0 V, terminated
To Within 1% of Final Value		25		ns	C_B	VH = 3.0 V, VL = 0.0 V, terminated
Dynamic Performance, VT (VH or VL to VT and VT to VH or VL)						Toggle RCVxx
Propagation Delay Time		3.7		ns	C_B	VH = 3.0 V, VT = 1.5 V, VL = 0.0 V, terminated
Delay Matching, Edge to Edge		150		ps	C_B	VH = 3.0 V, VT = 1.5 V, VL = 0.0 V, terminated; rising vs. falling
Propagation Delay Tempco		4.0		ps/°C	C_T	VH = 3.0 V, VT = 1.5 V, VL = 0.0 V, terminated
Transition Time, Active to VT and VT to Active		1.0		ns	C_B	VH = 3.0 V, VT = 1.5 V, VL = 0.0 V, terminated; 20% to 80%
Dynamic Performance, Inhibit (VH or VL to/from Inhibit)						Toggle RCVxx
Propagation Delay Time						VH = +1.0 V, VL = −1.0 V, terminated
Active to Inhibit		4.5		ns	C_B	
Inhibit to Active		7.9		ns	C_B	
Transition Time						VH =+1.0 V, VL = −1.0 V, terminated; 20% to 80%
Active to Inhibit		2.9		ns	C_B	
Inhibit to Active		0.65		ns	C_B	
I/O Spike		190		mV	C_B	VH = 0.0 V, VL = 0.0 V, terminated

[1] The xP pins include DATA0P, DATA1P, RCV0P, and RCV1P; the xN pins include DATA0N, DATA1N, RCV0N, and RCV1N. For example, push 6 mA into the DATA0P pin, force 1.3 V into DATA0N, and measure the voltage from DATA0P to DATA0N.

REFLECTION CLAMP

Clamp accuracy specifications apply when VCH > VCL.

Table 3.

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
VCH						
Range	−1.0		+6.75	V	D	
Uncalibrated Accuracy	−200	±50	+200	mV	P	Driver high-Z, sinking 1 mA; VCH error measured at the calibration points of 0.0 V and 5.0 V
Resolution		0.6	0.75	mV	P_F	Driver high-Z, sinking 1 mA; after two-point gain/offset calibration; range/number of DAC bits as measured at the calibration points of 0.0 V and 5.0 V
DNL		±1		mV	C_T	Driver high-Z, sinking 1 mA; after two-point gain/offset calibration
INL	−40	±2	+40	mV	P	Driver high-Z, sinking 1 mA; after two-point gain/offset calibration; measured over VCH range of −1.0 V to +6.75 V
Tempco		−0.3		mV/°C	C_T	Measured at calibration points
VCL						
Range	−1.25		+5.75	V	D	
Uncalibrated Accuracy	−200	±50	+200	mV	P	Driver high-Z, sourcing 1 mA; VCL error measured at the calibration points of 0.0 V and 5.0 V
Resolution		0.6	0.75	mV	P_F	Driver high-Z, sourcing 1 mA; after two-point gain/offset calibration; range/number of DAC bits as measured at the calibration points of 0.0 V and 5.0 V
DNL		±1		mV	C_T	Driver high-Z, sourcing 1 mA; after two-point gain/offset calibration
INL	−40	±2	+40	mV	P	Driver high-Z, sourcing 1 mA; after two-point gain/offset calibration; measured over VCL range of −1.0 V to +5.75 V
Tempco		0.5		mV/°C	C_T	Measured at calibration points
DC CLAMP CURRENT LIMIT						
VCH	−120	−85	−60	mA	P	Driver high-Z, VCH = 0 V, VCL = −1.0 V, V_{DUTx} = +5 V
VCL	60	85	120	mA	P	Driver high-Z, VCH = 6.75 V, VCL = 5.0 V, V_{DUTx} = 0.0 V
DUTGND VOLTAGE ACCURACY	−7	±1	+7	mV	P	Over ±0.1 V range; measured at the endpoints of VCH and VCL functional range

NORMAL WINDOW COMPARATOR

VOH tests done with VOL = −1.25 V; VOL tests done with VOH = 6.0 V, unless otherwise specified.

Table 4.

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
DC SPECIFICATIONS						
Input Voltage Range	−1.25		+6.75	V	D	
Differential Voltage Range	±0.1		±8.0	V	D	
Comparator Input Offset Voltage Accuracy, Uncalibrated	−150	±30	+150	mV	P	Offset measured at the calibration points of 0.0 V and 5.0 V
Comparator Threshold Resolution		0.6	1	mV	P_F	After two-point gain/offset calibration; range/number of DAC bits as measured at the calibration points of 0 V and 5 V
Comparator Threshold DNL		±1		mV	C_T	After two-point gain/offset calibration
Comparator Threshold INL	−7	±1.3	+7	mV	P	After two-point gain/offset calibration; measured over VOH, VOL range of −1.25 V to +6.75 V
Comparator Input Offset Voltage Tempco		±100		µV/°C	C_T	Measured at calibration points
DUTGND Voltage Accuracy	−7	±0.5	+7	mV	P	Over ±0.1 V range; measured at endpoints of VOH and VOL functional range

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
Comparator Uncertainty Range		6.0		mV	C_B	V_{DUTx} = 0 V, sweep comparator threshold to determine uncertainty region
DC Hysteresis		0.5		mV	C_B	V_{DUTx} = 0 V
DC PSRR		±5		mV/V	C_T	Measured at calibration points
Digital Output Characteristics						
Internal Pull-Up Resistance to Comparator, COMP_VTT Pin	40	50	60	Ω	P	Pull 1 mA and 10 mA from Logic 1 leg and measure ΔV to calculate resistance; measured ΔV/9 mA; done for both comparator logic states
V_{COMP_VTT} Range	3.3		5.0	V	D	
Common-Mode Voltage		V_{COMP_VTT} − 1.88		V	C_T	Measured with 100 Ω differential termination
	V_{COMP_VTT} − 2.075		V_{COMP_VTT} − 1.675	V	P	Measured with no external termination
Differential Voltage		250		mV	C_T	Measured with 100 Ω differential termination
	400	500	600	mV	P	Measured with no external termination
Rise/Fall Time, 20% to 80%		450		ps	C_B	Measured with each comparator leg terminated 50 Ω to GND
AC SPECIFICATIONS						Input transition time = 800 ps, 10% to 90%; measured with each comparator leg terminated 50 Ω to GND, unless otherwise specified
Propagation Delay, Input to Output		1.75		ns	C_B	V_{DUTx} = 0 V to 1.0 V swing, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = +0.50 V, VOL = −1.25 V; low-side measurement: VOH = +6.75 V, VOL = +0.50 V
Propagation Delay Tempco		5		ps/°C	C_T	V_{DUTx} = 0 V to 1.0 V swing, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = +0.50 V, VOL = −1.25 V; low-side measurement: VOH = +6.75 V, VOL = +0.50 V
Propagation Delay Matching						V_{DUTx} = 0 V to 1.0 V swing, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = +0.50 V, VOL = −1.25 V; low-side measurement: VOH = +6.75 V, VOL = +0.50 V
High Transition to Low Transition		200		ps	C_B	
High to Low Comparator		50		ps	C_B	
Propagation Delay Change (with Respect To)						
Slew Rate, 800 ps, 1 ns, 1.2 ns, and 2.2 ns (10% to 90%)		50		ps	C_B	V_{DUTx} = 0 V to 1.0 V swing, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = +0.50 V, VOL = −1.25 V; low-side measurement: VOH = +6.75V, VOL = +0.50 V
Overdrive, 250 mV and 1.0 V		75		ps	C_B	For 250 mV: V_{DUTx} = 0 V to 0.5 V swing; for 1.0 V: V_{DUTx} = 0 V to 1.25 V swing; Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = +0.25 V, VOL = −1.25 V; low-side measurement: VOH = +6.75 V, VOL = +0.25 V
Pulse Width, Sweep 1.6 ns to 10 ns		75		ps	C_B	V_{DUTx} = 0 V to 1.0 V swing @ 32.0 MHz, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = +0.5 V, VOL = −1.25 V; low-side measurement: VOH = +6.75 V, VOL = +0.5 V
Duty Cycle, 5% to 95%		50		ps	C_B	V_{DUTx} = 0 V to 1.0 V swing @ 1.0 MHz, Driver VTERM mode, VT =0.0 V; high-side measurement: VOH = +0.50 V, VOL = −1.25 V; low-side measurement: VOH = +6.75 V, VOL = +0.50 V
Minimum Pulse Width		2.0		ns	C_B	V_{DUTx} = 0 V to 1.0 V swing, Driver VTERM mode, VT = 0.0 V; less than 12% amplitude degradation measured by shmoo
Input Equivalent Bandwidth, Terminated		500		MHz	C_B	V_{DUTx} = 0 V to 1.0 V swing, Driver VTERM mode, VT = 0.0 V; as measured by shmoo
ERT High-Z Mode, 3 V, 20% to 80%		2.5		ns	C_B	V_{DUTx} = 0 V to 3.0 V swing, driver high-Z; as measured by shmoo; input transition time of ~2000 ps, 10% to 90%

DIFFERENTIAL COMPARATOR

VOH tests done with VOL = −1.1 V, VOL tests done with VOH = +1.1 V, unless otherwise specified.

Table 5.

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
DC SPECIFICATIONS						
Input Voltage Range	−1.25		+4.5	V	D	
Operational Differential Voltage Range	±0.05		±1.1	V	D	
Maximum Differential Voltage Range			±8	V	D	
Comparator Input Offset Voltage Accuracy, Uncalibrated	−150	±35	+150	mV	P/C_T	Offset measured at differential calibration points +1.0 V and −1.0 V, with common mode = 0.0 V
VOH, VOL Resolution		0.6	1	mV	P_F	After two-point gain/offset calibration; range/number of DAC bits as measured at differential calibration points +1.0 V and −1.0 V, with common mode = 0.0 V
VOH, VOL DNL		±1		mV	C_T	After two-point gain/offset calibration; common mode = 0.0 V
VOH, VOL INL	−15	±2.0	+15	mV	P	After two-point gain/offset calibration; measured over VOH, VOL range of −1.1 V to +1.1 V, common mode = 0.0 V
VOH, VOL Offset Voltage Tempco		±200		µV/°C	C_T	Measured at calibration points
Comparator Uncertainty Range		18		mV	C_B	V_{DUTx} = 0 V, sweep comparator threshold to determine uncertainty region
DC Hysteresis		0.5		mV	C_B	V_{DUTx} = 0 V
CMRR		0.15	1	mV/V	P	Offset measured at common-mode voltage points of −1.5 V and +4.5 V, with differential voltage = 0.0 V
DC PSRR		±1.5		mV/V	C_T	Measured at calibration points
AC SPECIFICATIONS						Input transition time = 800 ps, 10% to 90%, measured with each comparator leg terminated 50 Ω to GND
Propagation Delay, Input to Output		1.7		ns	C_B	V_{DUT0} = 0 V, V_{DUT1} = −0.5 V to +0.5 V swing, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = 0.0 V, VOL = −1.1 V; low-side measurement: VOH = +1.1 V, VOL = 0.0 V; repeat for other DUT channel
Propagation Delay Tempco		5		ps/°C	C_T	V_{DUT0} = 0 V, V_{DUT1} = −0.5 V to +0.5 V swing, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = 0.0 V, VOL = −1.1 V; low-side measurement: VOH = +1.1 V, VOL = 0.0 V; repeat for other DUT channel
Propagation Delay Matching						V_{DUT0} = 0 V, V_{DUT1} = −0.5 V to +0.5 V swing, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = 0.0 V, VOL = −1.1 V; low-side measurement: VOH = +1.1 V, VOL = 0.0 V; repeat for other DUT channel
High Transition to Low Transition		100		ps	C_B	
High-to-Low Comparator		50		ps	C_B	
Propagation Delay Change (with Respect To)						V_{DUT0} = 0 V, V_{DUT1} = −0.5 V to +0.5 V swing, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = 0.0 V, VOL = −1.1 V; low-side measurement: VOH = +1.1 V, VOL = 0.0 V; repeat for other DUT channel
Slew Rate, 800 ps, 1 ns, 1.2 ns, and 2.2 ns (10% to 90%)		60		ps	C_B	V_{DUT0} = 0 V, V_{DUT1} = −0.5 V to +0.5 V swing, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = 0.0 V, VOL = −1.1 V; low-side measurement: VOH = +1.1 V, VOL = 0.0 V; repeat for other DUT channel
Overdrive, 250 mV and 750 mV		100		ps	C_B	V_{DUT0} = 0 V, for 250 mV: V_{DUT1} = 0 V to 0.5 V swing; for 750 mV: V_{DUT1} = 0 V to 1.0 V swing, Driver VTERM mode, VT = 0.0 V; VOH = −0.25 V; repeat for other DUT channel with comparator threshold = +0.25 V
Pulse Width, Sweep from 1.6 ns to 10 ns		75		ps	C_B	V_{DUT0} = 0 V, V_{DUT1} = −0.5 V to +0.5 V swing @ 32 MHz, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = 0.0 V, VOL = −1.1 V; low-side measurement: VOH = +1.1 V, VOL = 0.0 V; repeat for other DUT channel
Duty Cycle, 5% to 95%		60		ps	C_B	V_{DUT0} = 0 V, V_{DUT1} = −0.5 V to +0.5 V swing @ 1 MHz, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = 0.0 V, VOL = −1.1 V; low-side measurement: VOH = +1.1 V, VOL = 0.0 V; repeat for other DUT channel

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
Minimum Pulse Width		2.5		ns	C_B	V_{DUT0} = 0 V, V_{DUT1} = −0.5 V to +0.5 V swing, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = 0.0 V, VOL = −1.1 V; low-side measurement: VOH = +1.1 V, VOL = 0.0 V; less than 10% amplitude degradation measured by shmoo; repeat for other DUT channel
Input Equivalent Bandwidth, Terminated		400		MHz	C_B	V_{DUT0} = 0 V, V_{DUT1} = −0.5 V to +0.5 V swing, Driver VTERM mode, VT = 0.0 V; high-side measurement: VOH = 0.0 V, VOL = −1.1 V; low-side measurement: VOH = +1.1 V, VOL = 0.0 V; less than 22% amplitude degradation measured by shmoo; repeat for other DUT channel

ACTIVE LOAD

See the Truth Tables section and Table 29 for load control information.

Table 6.

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
DC SPECIFICATIONS						Load active on, RCV active, unless otherwise noted
Input Characteristics						
VCOM Voltage Range	−1.00		+6.50	V	D	
V_{DUT} Range	−1.25		+6.75	V	D	
VCOM Accuracy, Uncalibrated	−200	±30	+200	mV	P	IOH = IOL = 6 mA, VCOM error measured at the calibration points of 0.0 V and 5.0 V
VCOM Resolution		0.6	1	mV	P_F	IOH = IOL = 6 mA, after two-point gain/offset calibration; range/number of DAC bits as measured at the calibration points of 0.0 V and 5.0 V
VCOM DNL		±1		mV	C_T	IOH = IOL = 6 mA, after two-point gain/offset calibration
VCOM INL	−7	±2	+7	mV	P	IOH = IOL = 6 mA, after two-point gain/offset calibration; measured over VCOM range of −1.00 V to +6.50 V
DUTGND Voltage Accuracy	−7	±1	+7	mV	P	Over ±0.1 V range; measured at end points of VCOM functional range
Output Characteristics						
IOL						
Maximum Source Current	12			mA	D	
Uncalibrated Offset	−600	±100	+600	µA	P	IOH = 0 mA, VCOM = 1.5 V, V_{DUTx} = 0.0 V, IOL offset calculated from the calibration points of 1 mA and 11 mA
Uncalibrated Gain	−12	±4	+12	%	P	IOH = 0 mA, VCOM = 1.5 V, V_{DUTx} = 0.0 V, IOL gain calculated from the calibration points of 1 mA and 11 mA
Resolution		1.5	2	µA	P_F	IOH = 0 mA, VCOM = 1.5 V, V_{DUTx} = 0.0 V, after two-point gain/offset calibration; range/number of DAC bits as measured at the calibration points of 1 mA and 11 mA
DNL		±3.0		µA	C_T	IOH = 0 mA, VCOM = 1.5 V, V_{DUTx} = 0.0 V, after two-point gain/offset calibration
INL	−80	±20	+80	µA	P	IOH = 0 mA, VCOM = 1.5 V, V_{DUTx} = 0.0 V, after two-point gain/offset calibration; measured over IOL range of 0 mA to 12 mA
90% Commutation Voltage			0.25	V	P	IOH = IOL = 12 mA, VCOM = 2.0 V, measure IOL reference at V_{DUTx} = −1.0 V, measure IOL current at V_{DUTx} = +1.75 V, ensure > 90% of reference current
IOH						
Maximum Sink Current	12			mA	D	
Uncalibrated Offset	−600	±100	+600	µA	P	IOL = 0 mA, VCOM = 1.5 V, V_{DUTx} = 3.0 V, IOH offset calculated from the calibration points of 1 mA and 11 mA
Uncalibrated Gain	−12	±4	+12	%	P	IOL = 0 mA, VCOM = 1.5 V, V_{DUTx} = 3.0 V, IOH gain calculated from the calibration points of 1 mA and 11 mA
Resolution		1.5	2	µA	P_F	IOL = 0 mA, VCOM = 1.5 V, V_{DUTx} = 3.0 V, after two-point gain/offset calibration; range/number of DAC bits as measured at the calibration points of 1 mA and 11 mA
DNL		±3.0		µA	C_T	IOL = 0 mA, VCOM = 1.5 V, V_{DUTx} = 3.0 V, after two-point gain/offset calibration

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
INL	−80	±20	+80	µA	P	IOL = 0 mA, VCOM = 1.5 V, V_{DUTx} = 3.0 V, after two-point gain/offset calibration; measured over IOH range of 0 mA to 12 mA
90% Commutation Voltage			0.25	V	P	IOH = IOL =12 mA, VCOM = 2.0 V, measure IOH reference at V_{DUTx} = 5.0 V, measure IOH current at V_{DUTx} = 2.25 V, ensure > 90% of reference current
Output Current Tempco		±1.5		µA/°C	C_T	Measured at calibration points
AC SPECIFICATIONS						Load active on, unless otherwise noted
Dynamic Performance						
Propagation Delay, Load Active On to Load Active Off; 50%,90%		7.3		ns	C_B	Toggle RCV, DUTx terminated 50 Ω to GND, IOH = IOL = 12 mA, VH = VL = 0 V, VCOM = +1.25 V for IOL and VCOM = −1.25 V for IOH; measured from 50% point of RCVxP − RCVxN to 90% point of final output, repeat for drive low and high
Propagation Delay, Load Active Off to Load Active On; 50%, 90%		10.3		ns	C_B	Toggle RCV, DUTx terminated 50 Ω to GND, IOH = IOL = 12 mA, VH = VL = 0 V, VCOM = +1.25 V for IOL and VCOM = −1.25 V for IOH; measured from 50% point of RCVxP − RCVxN to 90% point of final output, repeat for drive low and high
Propagation Delay Matching		3.0		ns	C_B	Toggle RCV, DUTx terminated 50 Ω to GND, IOH = IOL = 12 mA, VH = VL = 0 V, VCOM = +1.25 V for IOL and VCOM = −1.25 V for IOH; active on vs. active off, repeat for drive low and high
Load Spike		190		mV	C_B	Toggle RCV, DUTx terminated 50 Ω to GND, IOH = IOL = 0 mA, VH = VL = 0 V, VCOM = +1.25 V for IOL and VCOM = −1.25 V for IOH; repeat for drive low and high
Settling Time to 90%		1.9		ns	C_B	Toggle RCV, DUTx terminated 50 Ω to GND, IOH = IOL = 12 mA, VH = VL = 0 V, VCOM = +1.25 V for IOL and VCOM = −1.25 V for IOH; measured at 90% of final value

PMU

FV is the force voltage, MV is the measure voltage, FI is the force current, MI is the measure current, FN is force nothing.

Table 7.

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
FORCE VOLTAGE (FV)						
Current Range A	±32			mA	D	
Current Range B	±2			mA	D	
Current Range C	±200			µA	D	
Current Range D	±20			µA	D	
Current Range E	±2			µA	D	
Force Input Voltage Range at Output for All Ranges	−1.25		+6.75	V	D	
Force Voltage Uncalibrated Accuracy for Range C	−100	±25	+100	mV	P	PMU enabled, FV, Range C, PE disabled, error measured at calibration points of 0.0 V and 5.0 V
Force Voltage Uncalibrated Accuracy for All Ranges		±25		mV	C_T	PMU enabled, FV, PE disabled, error measured at calibration points of 0.0 V and 5.0 V; repeat for each PMU current range
Force Voltage Offset Tempco for All Ranges		±25		µV/°C	C_T	Measured at calibration points for each PMU current range
Force Voltage Gain Tempco for All Ranges		±10		ppm/°C	C_T	Measured at calibration points for each PMU current range
Forced Voltage INL	−7	±2	+7	mV	P	PMU enabled, FV, Range C, PE disabled, after two-point gain/offset calibration; measured over output range of −1.25 V to +6.75 V
Force Voltage Compliance vs. Current Load						PMU enabled, FV, PE disabled, force −1.25 V, measure voltage while PMU sinking zero and full-scale current; measure ΔV; force 6.75 V, measure voltage while PMU sourcing zero and full-scale current; measure ΔV; repeat for each PMU current range
Range A		±4		mV	C_T	
Range B to Range E		±1		mV	C_T	

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
Current Limit, Source, and Sink						
Range A	108	140	180	%FS	P	PMU enabled, FV, PE disabled; sink: force 2.5 V, short DUTx to 6.0 V; source: force 2.5 V, short DUTx to −1.0 V; Range A FS = 32 mA, 108% FS = 35 mA, 180% FS = 58 mA
Range B to Range E	120	145	180	%FS	P	PMU enabled, FV, PE disabled; sink: force 2.5 V, short DUTx to 6.0 V; source: force 2.5 V, short DUTx to −1.0 V; repeat for each PMU current range; example: Range B FS = 2 mA, 120 % FS = 2.4 mA, 180% FS = 3.6 mA
DUTGND Voltage Accuracy	−7	±1	+7	mV	P	Over ±0.1 V range; measured at endpoints of FV functional range
MEASURE CURRENT (MI)						V_{DUTx} externally forced to 0.0V, unless otherwise specified; ideal MEASOUT transfer functions: $V_{MEASOUT01}$ [V] = ($I_{MEASOUT01}$ × 5/FSR) + 2.5 + V_{DUTGND} I($V_{MEASOUT01}$) [A] = ($V_{MEASOUT01}$ − V_{DUTGND} − 2.5) × FSR/5
Measure Current, Pin DUTx Voltage Range for All Ranges	−1.5		+6.0	V	D	
Measure Current Uncalibrated Accuracy						
Range A		±500		µA	C_T	PMU enabled, FIMI, Range A, PE disabled, error at calibration points −25 mA and +25 mA, error = (I($V_{MEASOUT01}$) − I_{DUTx})
Range B	−400	±3.0	+400	µA	P	PMU enabled, FIMI, Range B, PE disabled, error at calibration points −1.6 mA and +1.6 mA, error = (I($V_{MEASOUT01}$) − I_{DUTx})
Range C		± 2.00		µA	C_T	PMU enabled, FIMI, PE disabled, error at calibration points of ±80% FS, error = (I($V_{MEASOUT01}$)$_1$ − I_{DUTx})
Range D		±0.30		µA	C_T	PMU enabled, FIMI, PE disabled, error at calibration points of ±80% FS, error = (I($V_{MEASOUT01}$) − I_{DUTx})
Range E		±0.08		µA	C_T	PMU enabled, FIMI, PE disabled, error at calibration points of ±80% FS, error = (I($V_{MEASOUT01}$) − I_{DUTx})
Measure Current Offset Tempco						
Range A		±2		µA/°C	C_T	Measured at calibration points
Range B		±25		nA/°C	C_T	Measured at calibration points
Range C		±5		nA/°C	C_T	Measured at calibration points
Range D and Range E		±1		nA/°C	C_T	Measured at calibration points
Measure Current Gain Error, Nominal Gain = 1						
Range A		±2.5		%	C_T	PMU enabled, FIMI, PE disabled, gain error from calibration points ±80% FS
Range B	−20	±2	+20	%	P	PMU enabled, FIMI, Range B, PE disabled, gain error from calibration points ±1.6 mA
Range C to Range E		±4		%	C_T	PMU enabled, FIMI, PE disabled, gain error from calibration points ±80% FS
Measure Current Gain Tempco						Measured at calibration points
Range A		±300		ppm/°C	C_T	
Range B to Range E		±50		ppm/°C	C_T	
Measure Current INL						
Range A		±0.05		%FSR	C_T	PMU enabled, FIMI, Range A, PE disabled, after two-point gain/offset calibration, measured over FSR output of −32 mA to +32 mA
Range B	−0.02		+0.02	%FSR	P	PMU enabled, FIM,I Range B, PE disabled, after two-point gain/offset calibration measured over FSR output of −2 mA to +2 mA
Range B to Range E		±0.01		%FSR	C_T	PMU enabled, FIMI, PE disabled, after two-point gain/offset calibration; measured over FSR output
FVMI DUT Pin Voltage Rejection	−0.01		+0.01	%FSR/V	P	PMU enabled, FVMI, Range B, PE disabled, force −1 V and +5 V into load of 1 mA; measure ΔI reported at MEASOUT01
DUTGND Voltage Accuracy		±2.5		mV	C_T	Over ±0.1 V range; measured at endpoints of MI functional range

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
FORCE CURRENT (FI)						V_{DUTx} externally forced to 0.0V, unless otherwise specified, ideal force current transfer function: I_{FORCE} = (PMUDAC − 2.5) × (FSR/5)
Force Current, DUTx Pin Voltage Range for All Ranges	−1.25		+6.75	V	D	
Force Current Uncalibrated Accuracy						
Range A	−5.0	±0.5	+5.0	mA	P	PMU enabled, FIMI, Range A, PE disabled, error at calibration points of −25 mA and +25 mA
Range B	−400	±40	+400	µA	P	PMU enabled, FIMI, Range B, PE disabled, error at calibration points of −1.6 mA and 1.6 mA
Range C	−40	±4	+40	µA	P	PMU enabled, FIMI, Range C, PE disabled, error at calibration points of ±80% FS
Range D	−4	±0.4	+4	µA	P	PMU enabled, FIMI, Range D, PE disabled, error at calibration points of ±80% FS
Range E	−400	±75	+400	nA	P	PMU enabled, FIMI, Range E, PE disabled, error at calibration points of ±80% FS
Force Current Offset Tempco						
Range A		±1		µA/°C	C_T	Measured at calibration points
Range B		±80		nA/°C	C_T	Measured at calibration points
Range C to Range E		±4		nA/°C	C_T	Measured at calibration points
Forced Current Gain Error, Nominal Gain = 1	−20	±4	+20	%	P	PMU enabled, FIMI, PE disabled, gain error from calibration points of ±80% FS
Forced Current Gain Tempco						Measured at calibration points
Range A		−500		ppm/°C	C_T	
Range B to Range E		±75		ppm/°C	C_T	
Force Current INL						
Range A	−0.3	±0.05	+0.3	%FSR	P	PMU enabled, FIMI, Range A, PE disabled, after two-point gain/offset calibration; measured over FSR output of −32 mA to +32 mA
Range B to Range E	−0.2	±0.015	+0.2	%FSR	P	PMU enabled, FIMI, PE disabled, after two-point gain/offset calibration; measured over FSR output
Force Current Compliance vs. Voltage Load						PMU enabled, FIMV, PE disabled; force positive full-scale current driving −1.5 V and +6.0 V, measure ΔI @ DUTx pin; force negative full-scale current driving −1.25 V and +6.75 V, measure ΔI @ DUTx pin
Range A to Range D	−0.6	±0.06	+0.6	%FSR	P	
Range E	−1.0	±0.1	+1.0	%FSR	P	
MEASURE VOLTAGE						
Measure Voltage Range	−1.5		+6.0	V	D	
Measure Voltage Uncalibrated Accuracy	−25	±2.0	+25	mV	P	PMU enabled, FVMV, Range B, PE disabled, error at calibration points of 0 V and 5 V, error = ($V_{MEASOUT01}$ − V_{DUTx})
Measure Voltage Offset Tempco		±10		µV/°C	C_T	Measured at calibration points
Measure Voltage Gain Error	−0.2	±0.01	+0.2	%	P	PMU enabled, FVMV, Range B, PE disabled, gain error from calibration points of 0 V and 5 V
Measure Voltage Gain Tempco		25		ppm/°C	C_T	Measured at calibration points
Measure Voltage INL	−7	±1	+7	mV	P	PMU enabled, FVMV, Range B, PE disabled, after two-point gain/offset calibration; measured over output range of −1.25 V to +6.75 V
Rejection of Measure V vs. I_{DUTx}	−1.5	±0.1	+1.5	mV	P	PMU enabled, FVMV, Range D, PE disabled, force 0 V into load of −10 µA and +10 µA; measure ΔV reported at MEASOUT01

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
MEASOUT01 DC CHARACTERISTICS						
MEASOUT01 Voltage Range	−1.5		+6.0	V	D	
DC Output Current			4	mA	D	
MEASOUT01 Pin Output Impedance		25	200	Ω	P	PMU enabled, FVMV, PE disabled; source resistance: PMU force +6.75 V and load with 0 mA and +4 mA; sink resistance: PMU force −1.25 V and load with 0 mA and −4 mA; resistance = ΔV/ΔI at MEASOUT01 pin
Output Leakage Current when Tristated	−1		+1	µA	P	Tested at −1.25 V and +6.75 V
Output Short-Circuit Current	−25		+25	mA	P	PMU enabled, FVMV, PE disabled; source: PMU force +6.75 V, short MEASOUT01 to −1.25 V; sink: PMU force −1.25 V, short MEASOUT01 to +6.75 V
VOLTAGE CLAMPS						
Low Clamp Range (VCL)	−1.25		+4.75	V	D	
High Clamp Range (VCH)	0.75		6.75	V	D	
Positive Clamp Voltage Droop	−300	+10	+300	mV	P	PMU enabled, FIMI, Range A, PE disabled, PMU clamps enabled, VCH = +5.0 V, VCL = −1.0 V, PMU force 2.0 mA and 32 mA into open; ΔV seen at DUTx pin
Negative Clamp Voltage Droop	−300	−10	+300	mV	P	PMU enabled, FIMI, Range A, PE disabled, PMU clamps enabled, VCH = +5.0 V, VCL = −1.0 V, PMU force −2.0 mA and −32 mA into open; ΔV seen at DUTx pin
Uncalibrated Accuracy	−250	±100	+250	mV	P	PMU enabled, FIMI, Range B, PE disabled, PMU clamps enabled, PMU force ±1 mA into open; VCH errors at calibration points 1.0 V and 5.0 V; VCL errors at the calibration points 0.0 V and 4.0 V
INL	−70	±5	+70	mV	P	PMU enabled, FIMI, Range B, PE disabled, PMU clamps enabled, PMU force ±1 mA into open; after two-point gain/offset calibration; measured over PMU clamp range
DUTGND Voltage Accuracy		±1		mV	C_T	Over ±0.1 V range; measured at endpoints of PMU clamp functional range
SETTLING/SWITCHING TIMES						SCAP = 330 pF, FFCAP = 220 pF
Voltage Force Settling Time to 0.1% of Final Value						PMU enabled, FV, PE disabled, program PMUDAC steps of 500 mV and 5.0 V; simulation of worst case, 2000 pF load, PMUDAC step of 5.0 V
Range A, 200 pF and 2000 pF Load		15		µs	S	
Range B, 200 pF and 2000 pF Load		20		µs	S	
Range C, 200 pF and 2000 pF Load		124		µs	S	
Range D, 200 pF and 2000 pF Load		1015		µs	S	
Range E, 200 pF and 2000 pF Load		3455		µs	S	
Voltage Force Settling Time to 1.0% of Final Value						PMU enabled, FV, PE disabled, start with PMUDAC programmed to 0.0 V, program PMUDAC to 500 mV
Range A, 200 pF and 2000 pF Load		14		µs	C_B	
Range B, 200 pF and 2000 pF Load		14		µs	C_B	
Range C, 200 pF and 2000 pF Load		14		µs	C_B	
Range D, 200 pF Load		45		µs	C_B	
Range D, 2000 pF Load		45		µs	C_B	
Range E, 200 pF Load		45		µs	C_B	
Range E, 2000 pF Load		225		µs	C_B	

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
Voltage Force Settling Time to 1.0% of Final Value						PMU enabled, FV, PE disabled, start with PMUDAC programmed to 0.0 V, program PMUDAC to 5.0 V
Range A, 200 pF and 2000 pF Load		4.0		µs	C_B	
Range B, 200 pF Load		4.2		µs	C_B	
Range B, 2000 pF Load		4.2		µs	C_B	
Range C, 200 pF Load		5.8		µs	C_B	
Range C, 2000 pF Load		19		µs	C_B	
Range D, 200 pF Load		50		µs	C_B	
Range D, 2000 pF Load		210		µs	C_B	
Range E, 200 pF Load		360		µs	C_B	
Range E, 2000 pF Load		610		µs	C_B	
Current Force Settling Time to 0.1% of Final Value						PMU enabled, FI, PE disabled, start with PMUDAC programmed to 0 current, program PMUDAC to FS current
Range A, 200 pF in Parallel with 120 Ω		8.2		µs	S	
Range B, 200 pF in Parallel with 1.5 kΩ		9.4		µs	S	
Range C, 200 pF in Parallel with 15.0 kΩ		30		µs	S	
Range D, 200 pF in Parallel with 150 kΩ		281		µs	S	
Range E, 200 pF in Parallel with 1.5 MΩ		2668		µs	S	
Current Force Settling Time to 1.0% of Final Value						PMU enabled, FI, PE disabled, start with PMUDAC programmed to 0 current, program PMUDAC to FS current
Range A, 200 pF in Parallel with 120 Ω		4.2		µs	C_B	
Range B, 200 pF in Parallel with 1.5 kΩ		4.3		µs	C_B	
Range C, 200 pF in Parallel with 15.0 kΩ		8.1		µs	C_B	
Range D, 200 pF in Parallel with 150 kΩ		205		µs	C_B	
Range E, 200 pF in Parallel with 1.5 MΩ		505		µs	C_B	
INTERACTION AND CROSSTALK						
Measure Voltage Channel-to-Channel Crosstalk		±0.125		%FSR	C_T	PMU enabled, FIMV, PE disabled, Range B, forcing 0 mA into 0 V load; other channel: Range A, forcing a step of 0 mA to 25 mA into 0 V load; report ΔV of MEASOUT01 pin under test; 0.125% × 8.0 V = 10 mV
Measure Current Channel-to-Channel Crosstalk		±0.01		%FSR	C_T	PMU enabled, FVMI, PE disabled, Range E, forcing 0 V into 0 mA current load; other channel: Range E, forcing a step of 0 V to 5 V into 0 mA current load; report ΔV of MEASOUT01 pin under test; 0.01% × 5.0 V = 0.5 mV

EXTERNAL SENSE (PMUS_CHx)

Table 8.

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
EXTERNAL SENSE (PMUS_CHX)						
Voltage Range	−1.25		+6.75	V	D	
Input Leakage Current	−20		+20	nA	P	Tested at −1.25 V and +6.75 V

DUTGND INPUT

Table 9.

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
DUTGND INPUT						
Input Voltage Range, Referenced to GND	−0.1		+0.1	V	D	
Input Bias Current		1	100	µA	P	Tested at −100 mV and +100 mV

SERIAL PERIPHERAL INTERFACE

Table 10.

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
SERIAL PERIPHERAL INTERFACE						
Serial Input Logic High	1.8		V_{CC}	V	P_F	
Serial Input Logic Low	0		0.7	V	P_F	
Input Bias Current	−10	1	+10	µA	P	Tested at 0.0 V and 3.3 V
SCLK Clock Rate		50		MHz	P_F	
SCLK Pulse Width		9		ns	C_T	
SCLK Crosstalk on DUTx Pin		8		mV	C_B	PE disabled, PMU FV enabled and forcing 0 V
Serial Output Logic High	V_{CC} − 0.4		V_{CC}	V	P_F	Sourcing 2 mA
Serial Output Logic Low	0		0.8	V	P_F	Sinking 2 mA
Update Time		10		µs	D	Maximum delay time required for the part to enter a stable state after a serial bus

HVOUT DRIVER

Table 11.

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
VHH BUFFER						VHH = (VT + 1 V) × 2 + DUTGND
Voltage Range	5.9		V_{PLUS} − 3.25	V	D	V_{PLUS} = 16.75 V nominal; in this condition, V_{HVOUT} max = 13.5 V
Output High	13.5			V	P	VHH mode enabled, RCV active, VHH level = full scale, sourcing 15 mA
Output Low			5.9	V	P	VHH mode enabled, RCV active, VHH level = zero scale, sinking 15 mA
Accuracy Uncalibrated	−500	±100	+500	mV	P	VHH mode enabled, RCV active, V_{HVOUT} error measured at the calibration points of 7 V and 12 V
Offset Tempco		1		mV/°C	C_T	Measured at calibration points
Resolution		1.21	1.5	mV	P_F	VHH mode enabled, RCV active, after two-point gain/offset calibration; range/number of DAC bits as measured at the calibration points of 7 V and 12 V
INL	−30	±15	+30	mV	P	VHH mode enabled, RCV active, after two-point gain/offset calibration; measured over VHH range of 5.9 V to 13.5 V
DUTGND Voltage Accuracy		±1		mV	C_T	Over ±0.1 V range; measured at endpoints of VHH functional range
Output Resistance		1	10	Ω	P	VHH mode enabled, RCV active, source: VHH = 10.0 V, I_{HVOUT} = 0 mA and 15 mA; sink: VHH = 6.5 V, I_{HVOUT} = 0 mA and −15 mA; ΔV/ΔI
DC Output Current Limit Source	60		100	mA	P	VHH mode enabled, RCV active, VHH = 10.0 V, short HVOUT pin to 5.9 V, measure current
DC Output Current Limit Sink	−100		−60	mA	P	VHH mode enabled, RCV active, VHH = 6.5 V, short HVOUT pin to 14.1 V, measure current
Rise Time (From VL or VH to VHH)		200		ns	C_B	VHH mode enabled, toggle RCV, VHH = 13.5 V, VL = VH = 3.0 V; 20% to 80%, for DATA = high and DATA = low
Fall Time (From VHH to VL or VH)		26		ns	C_B	VHH mode enabled, toggle RCV, VHH = 13.5 V, VL = VH = 3.0 V; 20% to 80%, for DATA = high and DATA = low
Preshoot, Overshoot, and Undershoot		±125		mV	C_B	VHH mode enabled, toggle RCV, VHH = 13.5 V, VL = VH = 3.0 V; for DATA = high and DATA = low
VL/VH BUFFER						
Voltage Range	−0.1		+6.0	V	D	
Accuracy Uncalibrated	−500	±100	+500	mV	P	VHH mode enabled, RCV inactive, error measured at the calibration points 0 V and 5 V
Offset Tempco		1		mV/°C	C_T	Measured at calibration points
Resolution		0.61	0.75	mV	P_F	VHH mode enabled, RCV inactive, after two-point gain/offset calibration; range/number of DAC bits as measured at the calibration points 0 V and 5 V
INL	−20	±4	+20	mV	P	VHH mode enabled, RCV inactive, after two-point gain/offset calibration; measured over range of −0.1 V to +6.0 V
DUTGND Voltage Accuracy		±2		mV	C_T	Over ±0.1 V range; measured at endpoints of VH and VL, functional range
Output Resistance	45	48	50	Ω	P	VHH mode enabled, RCV inactive, source: VH = 3.0 V, I_{HVOUT} = +1 mA and +50 mA; sink: VL = 2.0 V, I_{HVOUT} = −1 mA and −50 mA; ΔV/ΔI
DC Output Current Limit Source	60		100	mA	P	VHH mode enabled, RCV inactive, VH = +6.0 V, short HVOUT pin to −0.1 V, DATA high, measure current
DC Output Current Limit Sink	−100		−60	mA	P	VHH mode enabled, RCV inactive, VL = −0.1 V, short HVOUT pin to +6.0 V, DATA low, measure current
Rise Time (VL to VH)		11		ns	C_B	VHH mode enabled, RCV inactive, VL = 0.0 V, VH = 3.0 V, toggle DATA; 20% to 80%
Fall Time (VH to VL)		11.3		ns	C_B	VHH mode enabled, RCV inactive, VL = 0.0 V, VH = 3.0 V, toggle DATA; 20% to 80%
Preshoot, Overshoot, and Undershoot		±54		mV	C_B	VHH mode enabled, RCV inactive, VL = 0.0 V, VH = 3.0 V, toggle DATA

OVERVOLTAGE DETECTOR (OVD)

Table 12.

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
DC CHARACTERISTICS						
Programmable Voltage Range	−2.25		+7.0	V	D	
Accuracy Uncalibrated	−200		+200	mV	P	OVD offset errors measured at programmed levels of +7.0 V and −2.25 V
Hysteresis		112		mV	C_B	
LOGIC OUTPUT CHARACTERISTICS						
Off State Leakage		10	1000	nA	P	Disable OVD alarm, apply 3.3 V to OVD pin, measure leakage current
Maximum On Voltage @ 100 µA		0.2	0.7	V	P	Activate alarm, force 100 µA into OVD pin, measure active alarm voltage
Propagation Delay		1.9		µs	C_B	For OVD high: DUTx = 0 V to +6 V swing, OVD high = +3.0 V, OVD low = −2.25 V; for OVD low: DUTx = 0 V to +6 V swing, OVD high = +7.0 V, OVD low = +3.0 V

16-BIT DAC MONITOR MUX

Table 13.

Parameter	Min	Typ	Max	Unit	Test Level	Test Conditions/Comments
DC CHARACTERISTICS						
Programmable Voltage Range	−2.5		+7.5	V	D	
Output Resistance		16		kΩ	C_T	PMUDAC = 0.0 V, FV, I = 0, 200 µA; ΔV/ΔI

ABSOLUTE MAXIMUM RATINGS

Table 14.

Parameter	Rating
Supply Voltages	
Positive Supply Voltage (V_{DD} to GND)	−0.5 V to +11.5 V
Positive V_{CC} Supply Voltage (V_{CC} to GND)	−0.5 V to +4.0 V
Negative Supply Voltage (V_{SS} to GND)	−6.25 V to +0.5 V
Supply Voltage Difference (V_{DD} to V_{SS})	−1.0 V to +16.5 V
Reference Ground (DUTGND to GND)	−0.5 V to +0.5 V
AGND to DGND	−0.5 V to +0.5 V
VPLUS Supply Voltage (V_{PLUS} to GND)	−0.5 V to +17.5 V
Input Voltages	
Input Common-Mode Voltage	V_{SS} to V_{DD}
Short-Circuit Voltage[1]	−3.0 V to +8.0 V
High Speed Input Voltage[2]	0.0 V to V_{CC}
High Speed Differential Input Voltage[3]	0.0 V to V_{CC}
VREF	−0.5 V to +5.5 V
DUTx I/O Pin Current	
DCL Maximum Short-Circuit Current[4]	±140 mA
Temperature	
Operating Temperature, Junction	125°C
Storage Temperature Range	−65°C to +150°C

[1] R_L = 0 Ω, V_{DUT} continuous short-circuit condition (VH, VL, VT, high-Z, VCOM, clamp modes).
[2] DATAxP, DATAxN, RCVxP, RCVxN, under source R_L = 0 Ω.
[3] DATAxP to DATAxN, RCVxP, RCVxN.
[4] R_L = 0 Ω, VDUTx = −3 V to +8 V; DCL current limit. Continuous short-circuit condition. ADATE304 must current limit and survive continuous short circuit.

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

THERMAL RESISTANCE

Table 15. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}
84-Ball CSP_BGA	31.1	0.51

EXPLANATION OF TEST LEVELS

D Definition

S Design verification simulation

P 100% production tested

P_F Functionally checked during production test

C_T Characterized on tester

C_B Characterized on bench

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

Figure 2. Pin Configuration

Table 16. Pin Function Descriptions

Pin No.	Mnemonic	Description
A1	TEMPSENSE	Temperature Sense Output
A2	PMUS_CH1	PMU External Sense Path Channel 1
A3	VSSO_1 (Drive)	Driver Output Supply (−5.0 V) Channel 1
A4	DUT1	Device Under Test Channel 1
A5	VDDO_1 (Drive)	Driver Output Supply (+10.75 V) Channel 1
A6	VDDO_0 (Drive)	Driver Output Supply (+10.75 V) Channel 0
A7	DUT0	Device Under Test Channel 0
A8	VSSO_0 (Drive)	Driver Output Supply (−5.0 V) Channel 0
A9	PMUS_CH0	PMU External Sense Path Channel 0
A10	HVOUT	High Voltage Driver Output
B1	VDD/VDD_TMPSNS	Temperature Sense Supply (+10.75 V)
B2	SCAP1	PMU Stability Capacitor Connection Channel 1 (330 pF)
B3	VSS	Supply (−5.0 V)
B4	AGND	Analog Ground
B5	VDD	Supply (+10.75 V)
B6	VDD	Supply (+10.75 V)
B7	AGND	Analog Ground
B8	VSS	Supply (−5.0 V)
B9	SCAP0	PMU Stability Capacitor Connection Channel 0 (330 pF)
B10	VPLUS	Supply (+16.75 V)
C1	FFCAP_1B	PMU Feedforward Capacitor Connection B Channel 1 (220 pF)
C2	AGND	Analog Ground
C3	DATA1N	Driver Data Input (Negative) Channel 1
C4	VSS	Supply (−5.0 V)
C5	VDD	Supply (+10.75 V)
C6	VDD	Supply (+10.75 V)
C7	VSS	Supply (−5.0 V)
C8	DATA0N	Driver Data Input (Negative) Channel 0
C9	AGND	Analog Ground
C10	FFCAP_0B	PMU Feedforward Capacitor Connection B Channel 0 (220 pF)
D1	OVD_CH1	Overvoltage Detection Flag Output Channel 1
D2	VDD	Supply (+10.75 V)
D3	DATA1P	Driver Data Input (Positive) Channel 1
D8	DATA0P	Driver Data Input (Positive) Channel 0
D9	VDD	Supply (+10.75 V)
D10	OVD_CH0	Overvoltage Detection Flag Output Channel 0
E1	FFCAP_1A	PMU Feedforward Capacitor Connection A Channel 1 (220 pF)
E2	VSS	Supply (−5.0 V)
E3	RCV1N	Receive Data Input (Negative) Channel 1
E8	RCV0N	Receive Data Input (Negative) Channel 0
E9	VSS	Supply (−5.0 V)
E10	FFCAP_0A	PMU Feedforward Capacitor Connection A Channel 0 (220 pF)
F1	AGND	Analog Ground
F2	AGND	Analog Ground
F3	RCV1P	Receive Data Input (Positive) Channel 1
F8	RCV0P	Receive Data Input (Positive) Channel 0
F9	AGND	Analog Ground
F10	AGND	Analog Ground
G1	COMP_QL1P	Low-Side Comparator Output (Positive) Channel 1
G2	COMP_QL1N	Low-Side Comparator Output (Negative) Channel 1
G3	COMP_VTT1	Comparator Supply Termination Channel 1
G8	COMP_VTT0	Comparator Supply Termination Channel 0

Pin No.	Mnemonic	Description
G9	COMP_QL0N	Low-Side Comparator Output (Negative) Channel 0
G10	COMP_QL0P	Low-Side Comparator Output (Positive) Channel 0
H1	COMP_QH1P	High-Side Comparator Output (Positive) Channel 1
H2	COMP_QH1N	High-Side Comparator Output (Negative) Channel 1
H3	AGND	Analog Ground
H4	VSS	Supply (−5.0 V)
H5	VDD	Supply (+10.75 V)
H6	VDD	Supply (+10.75 V)
H7	VSS	Supply (−5.0 V)
H8	AGND	Analog Ground
H9	COMP_QH0N	High-Side Comparator Output (Negative) Channel 0
H10	COMP_QH0P	High-Side Comparator Output (Positive) Channel 0
J1	AGND	Analog Ground
J2	AGND	Analog Ground
J3	AGND	Analog Ground
J4	DAC16_MON	16-Bit DAC Monitor Mux Output
J5	DGND	Digital Ground
J6	SDIN	Serial Peripheral Interface (SPI) Data In
J7	$\overline{\text{RST}}$	Serial Peripheral Interface (SPI) Reset
J8	AGND	Analog Ground
J9	AGND	Analog Ground
J10	AGND	Analog Ground
K1	MEASOUT01/TEMPSENSE	Muxed Output Shared by PMU MEASOUT Channel 0, PMU MEASOUT Channel 1/ Temperature Sense and Temperature Sense GND Reference
K2	DUTGND	DUT Ground Reference
K3	AGND	Analog Ground
K4	$\overline{\text{CS}}$	Serial Peripheral Interface (SPI) Chip Select
K5	SDOUT	Serial Peripheral Interface (SPI) Data Out
K6	SCLK	Serial Peripheral Interface (SPI) Clock
K7	VCC	Supply (+3.3 V)
K8	AGND	Analog Ground
K9	VREF	+5 V DAC Reference Voltage
K10	VREF_GND	DAC Ground Reference

TYPICAL PERFORMANCE CHARACTERISTICS

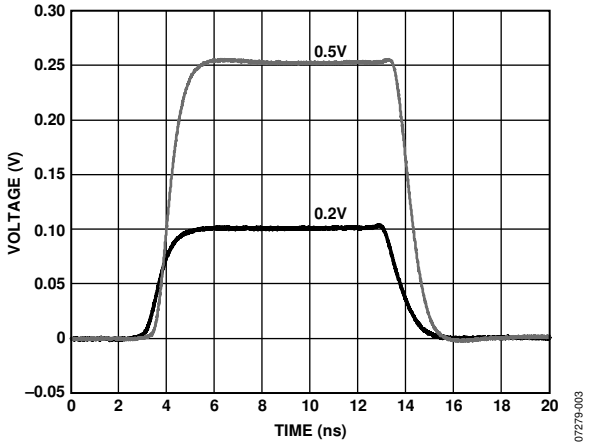

Figure 3. Driver Small Signal Response; VH = 0.2 V, 0.5 V; VL = 0.0 V; 50 Ω Termination

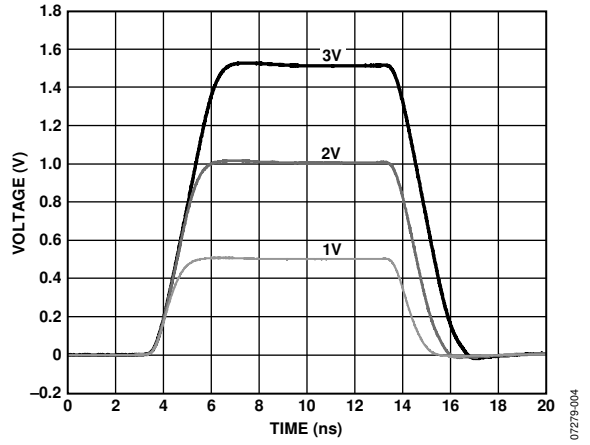

Figure 4. Driver Large Signal Response; VH = 1.0 V, 2.0 V, 3.0 V; VL = 0.0 V; 50 Ω Termination

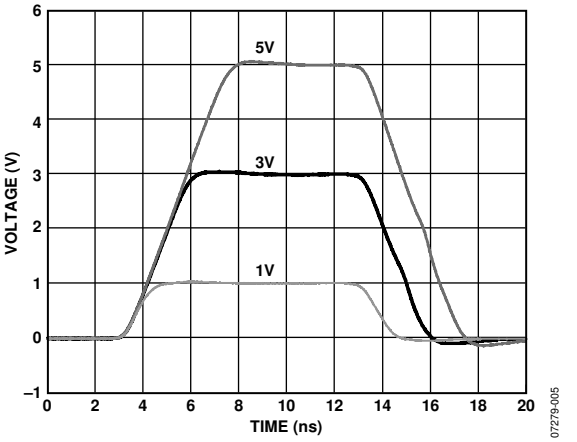

Figure 5. Driver Large Signal Response; VH = 1.0 V, 3.0 V, 5.0 V; VL = 0.0 V; 500 Ω Termination

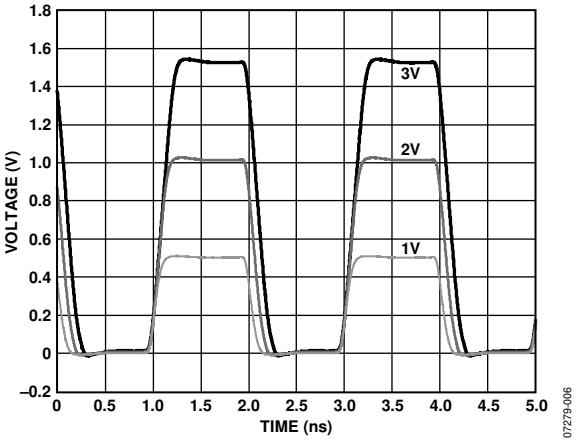

Figure 6. 50 MHz Driver Response; VH = 1.0 V, 2.0 V, 3.0 V; VL = 0.0 V, 50 Ω Termination

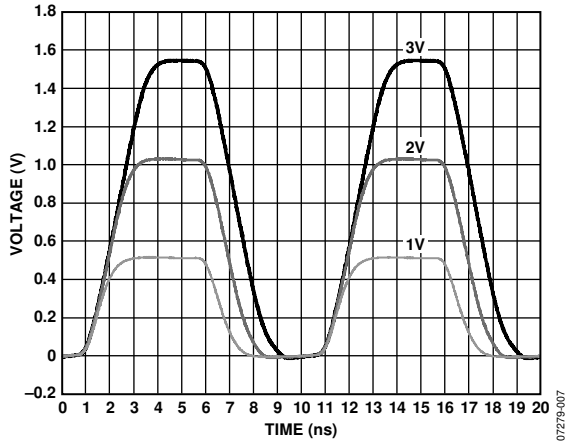

Figure 7. 100 MHz Driver Response; VH = 1.0 V, 2.0 V, 3.0 V; VL = 0.0 V; 50 Ω Termination

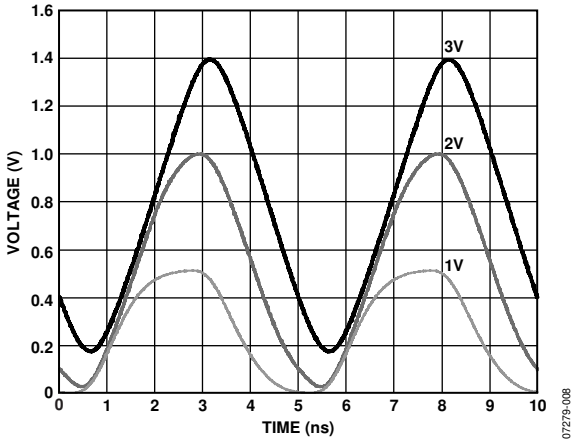

Figure 8. Response at 200 MH; VH = 1.0 V, 2.0 V, 3.0 V; VL = 0.0 V; 50 Ω Termination

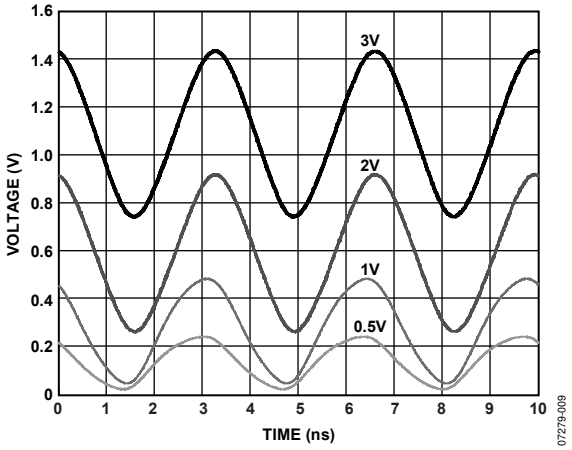

Figure 9. 300 MHz Driver Response; VH = 0.5 V, 1.0 V, 2.0 V, 3.0 V; VL = 0.0 V; 50 Ω Termination

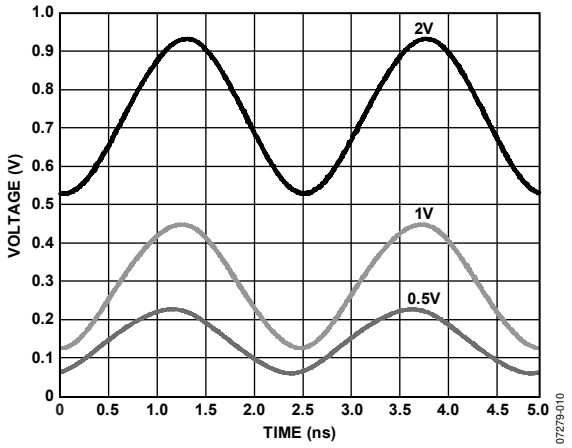

Figure 10. 400 MHz Driver Response; VH = 0.5 V, 1.0 V, 2.0 V, VL = 0.0 V; 50 Ω Termination

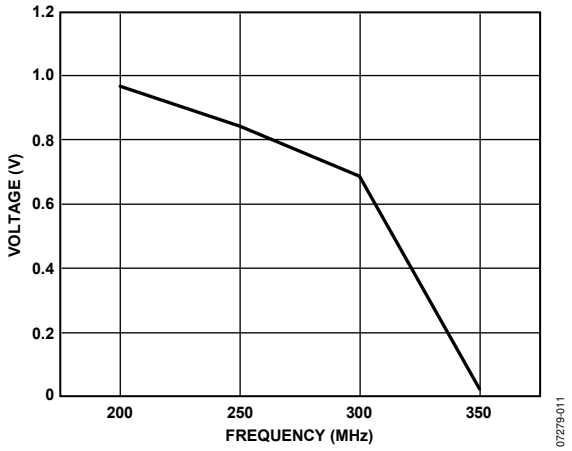

Figure 11. Driver Toggle Rate, VH = 2.0 V, VL = 0.0 V, 50 Ω Termination

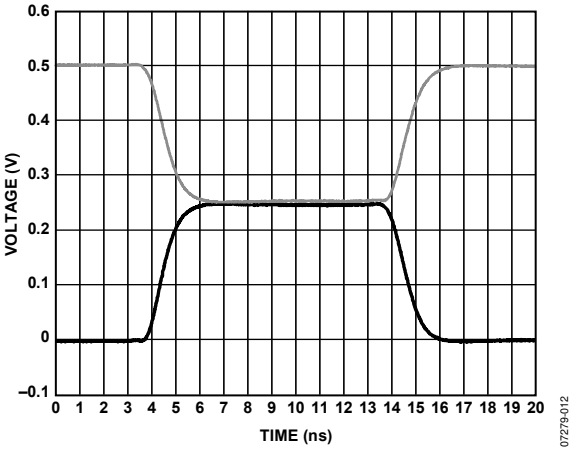

Figure 12. Driver Active (VH and VL) to and from VTERM Transition; VH = 1.0 V, VT = 0.5 V, VL = 0.0 V

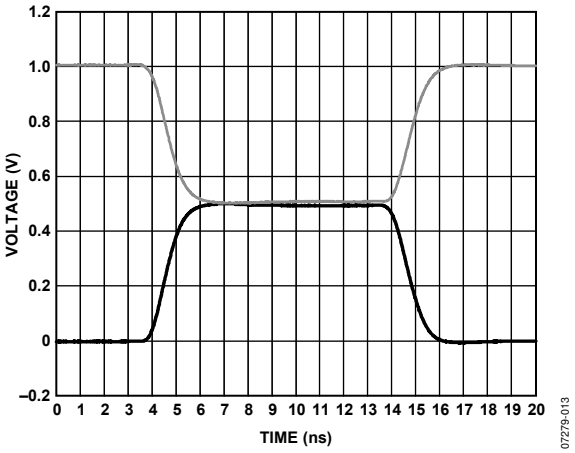

Figure 13. Driver Active (VH and VL) to and from VTERM Transition; VH = 2.0 V, VT = 1.0 V, VL = 0.0 V

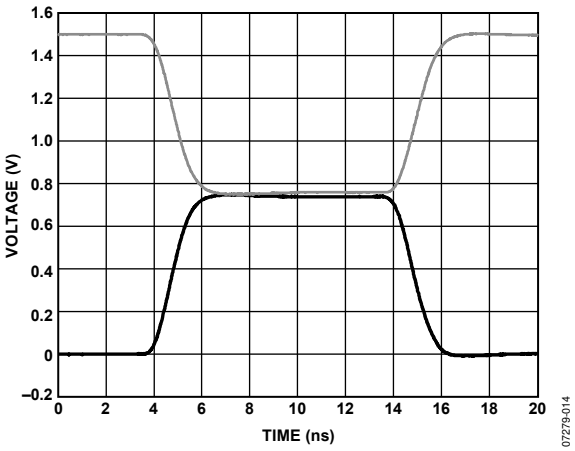

Figure 14. Driver Active (VH and VL) to and from VTERM Transition; VH = 3.0 V, VT = 1.5 V, VL = 0.0 V

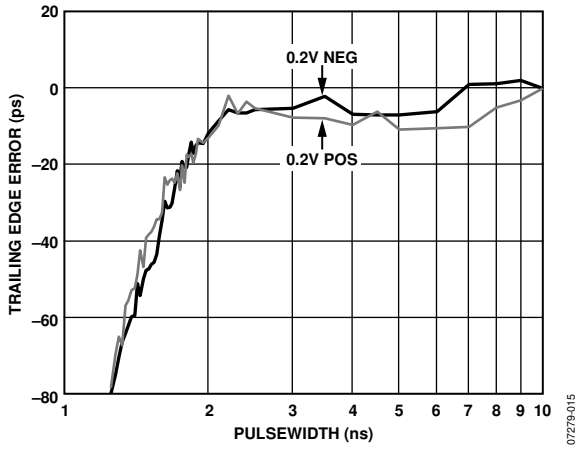

Figure 15. Driver Minimum Pulse Width; VH = 0.2 V, VL = 0.0 V

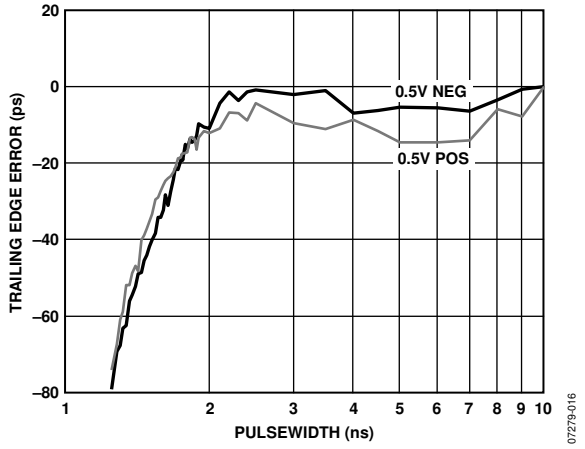

Figure 16. Driver Minimum Pulse Width; VH = 0.5 V, VL = 0.0 V

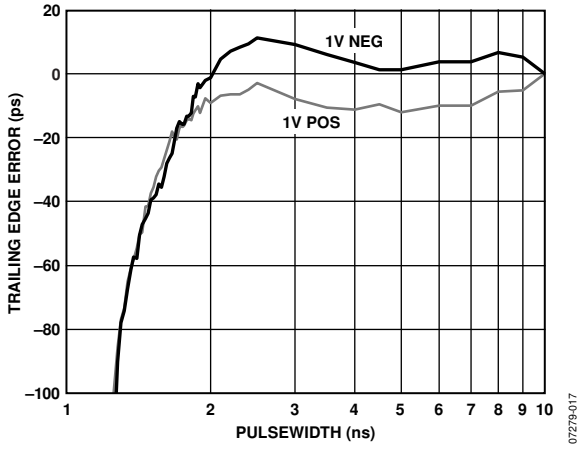

Figure 17. Driver Minimum Pulse Width; VH = 1.0 V, VL = 0.0 V

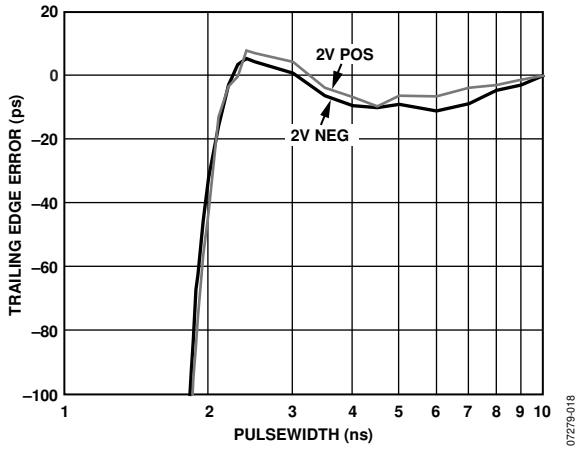

Figure 18. Driver Minimum Pulse Width; VH = 2.0 V, VL = 0.0 V

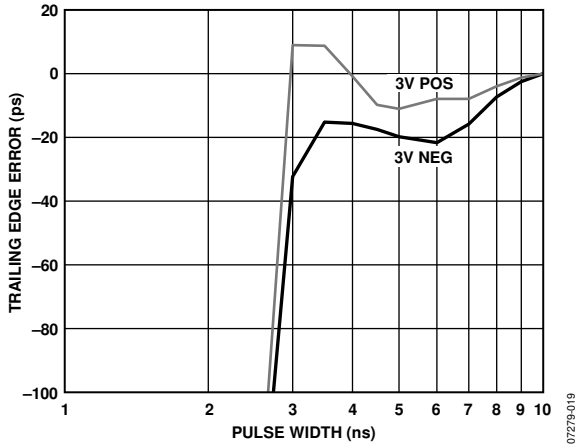

Figure 19. Driver Minimum Pulse Width; VH = 3.0 V, VL = 0.0 V

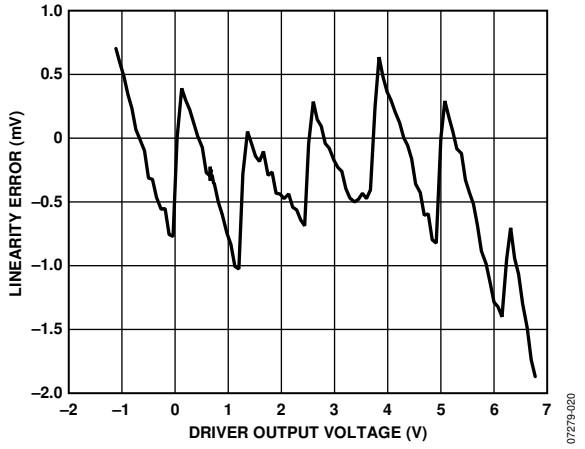

Figure 20. Driver VH Linearity Error