TOSHIBA

Glossary of Isolation Amplifier Terms

Outline

This application note provides the definitions of electrical characteristics of isolation amplifiers (analog output: TLP7820 and TLP7920, digital output: TLP7830 and TLP7930), which are a type of photocouplers.

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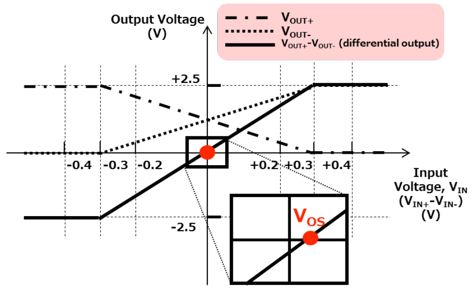
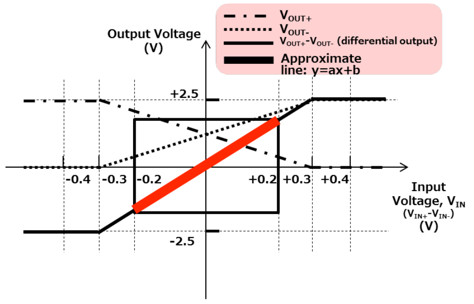
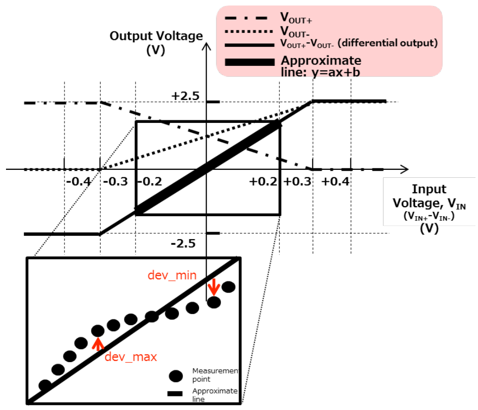
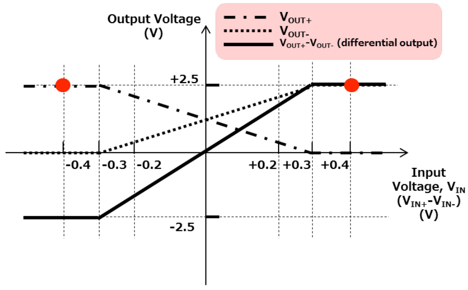
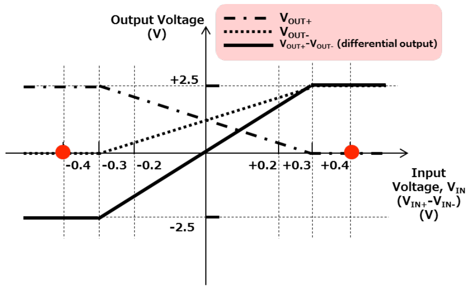
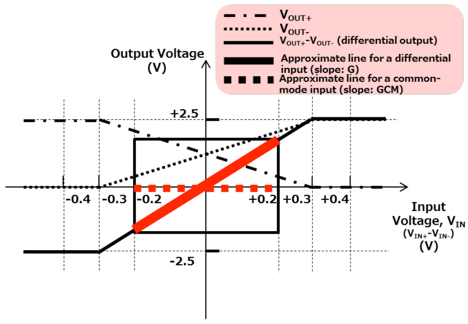
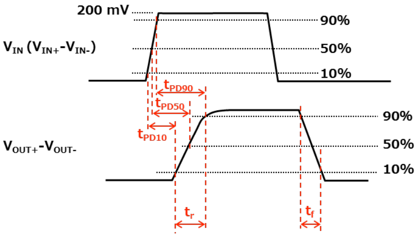
1. Electrical characteristics of analog-output isolation amplifiers

1.1 DC characteristics

Term	Symbol	Description	Characteristics Curve
Input offset voltage	V_{OS}	The converted offset voltage obtained by dividing the V_{OUT+}-V_{OUT-} at V_{IN} of 0V by the gain (G) with negative coefficient. (Intercept on the V_{IN} axis in the V_{IN}-(V_{OUT+}-V_{OUT-}) curve) V_{OS}=-{(V_{OUT+}-V_{OUT-})/(Gain G)} V_{IN}(V_{IN+}-V_{IN-}):differential input voltage V_{OUT+}-V_{OUT-}:differential output voltage	
Input offset voltage drift vs ambient temperature	$\|dV_{OS}/dT_a\|$	The temperature coefficient of the input offset voltage variations (from maximum to minimum value) in ambient temperature range.	
Input offset voltage drift vs input side supply voltage	$\|dV_{OS}/dV_{DD1}\|$	The voltage dependency coefficient of the input offset voltage variations (from maximum to minimum value) in input side supply voltage range.	
Gain	G	The slope (rate of change) of the straight line that approximates the V_{IN}-(V_{OUT+}-V_{OUT-}) curve. G is specified over the V_{IN} range between -0.2 and +0.2 V. V_{IN}(V_{IN+}-V_{IN-}):differential input voltage V_{OUT+}-V_{OUT-}:differential output voltage	
Gain drift vs ambient temperature	$\|dG/dT_a\|$	The temperature coefficient of the gain variations (from maximum to minimum value) in ambient temperature range.	
V_{OUT} non-linearity (±200 mV)	NL_{200}	The ratio of the sum of the maximum deviations in the positive and negative directions (dev_max and dev_min) of the measured points from the approximate straight line of V_{IN}-(V_{OUT+}-V_{OUT-}) curve to the full-scale differential output voltage ({2*(V_{OH}-V_{OL})}). NL_{200} is specified over the V_{IN} range between -0.2 and +0.2 V. NL_{200}=(|dev_max|+|dev_min|)/{2*(V_{OH}-V_{OL})} V_{IN}(V_{IN+}-V_{IN-}):differential input voltage V_{OUT+}-V_{OUT-}:differential output voltage	 (This figure should be considered merely as a guide.)
V_{OUT} non-linearity (±200 mV) drift vs ambient temperature	$\|dNL_{200}/dT_a\|$	The temperature coefficient of the non-linearity variations (from maximum to minimum value) in ambient temperature range.	
V_{OUT} non-linearity (±100mV)	NL_{100}	The ratio of the sum of the maximum deviations in the positive and negative directions (dev_max and dev_min) of the measured points from the approximate straight line of V_{IN}-(V_{OUT+}-V_{OUT-}) curve to the full-scale differential output voltage ({2*(V_{OH}-V_{OL})}). NL_{200} is specified over the V_{IN} range between -0.1 and +0.1 V. V_{IN}(V_{IN+}-V_{IN-}):differential input voltage V_{OUT+}-V_{OUT-}:differential output voltage	

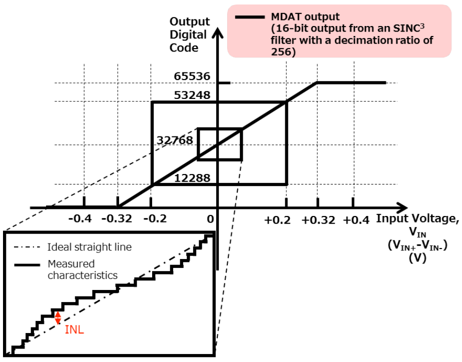
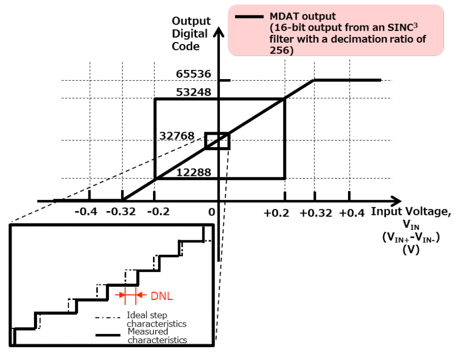
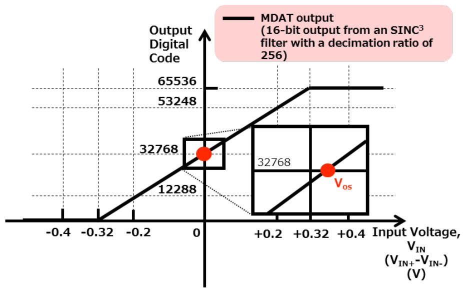
Term	Symbol	Description	Characteristics Curve
High-level output voltage	V_{OH}	Maximum single-phase output voltage of V_{OUT+} and V_{OUT-}.	
Low-level output voltage	V_{OL}	Minimum single-phase output voltage of V_{OUT+} and V_{OUT-}.	
Input common-mode rejection ratio	$CMRR_{IN}$	The ratio of the gain from a common-mode input GCM to the differential input G. $CMRR_{IN}$ is specified over the V_{IN} range between -0.2 and +0.2 V. $CMRR_{IN}$=20log(G/|GCM|) [dB]	
Equivalent input resistance	R_{IN}	Equivalent input resistance over the V_{IN}(V_{IN+}-V_{IN-}) range between -0.2 and +0.2 V.	-
Input bias current	I_{IN+}	The input current when the differential input voltage V_{IN}(V_{IN+}-V_{IN-}) is 0 V	-
Input side supply current (V_{DD1})	I_{DD1}	The supply current that flows through the input side when the differential input voltage V_{IN}(V_{IN+}-V_{IN-}) is 0 V	-
Output side supply current (V_{DD2})	I_{DD2}	The supply current that flows through the output side when the differential input voltage V_{IN}(V_{IN+}-V_{IN-}) is 0 V	-
Output resistance (V_{OUT})	R_{OUT}	Resistance of the output pin over the output current range of ±5 mA	-

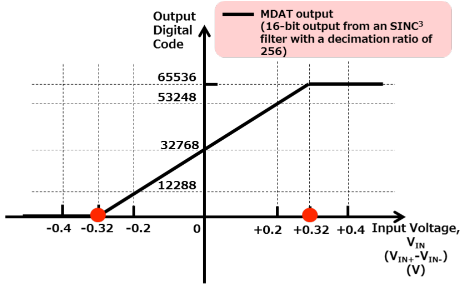
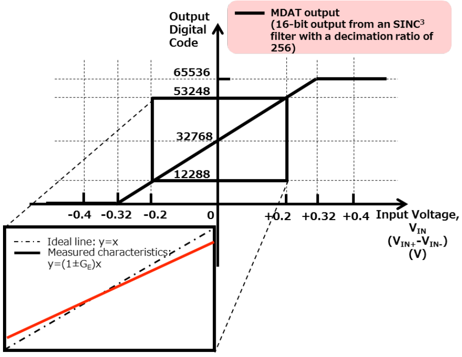
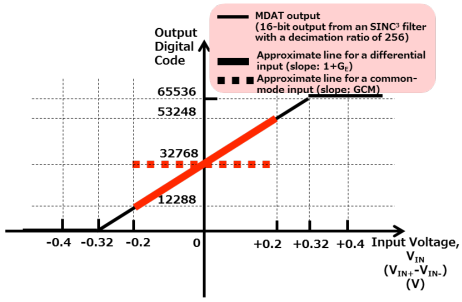
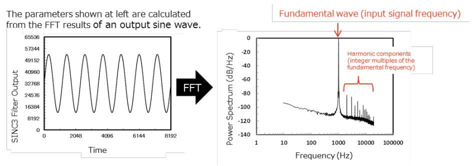
1.2 AC characteristics

Term	Symbol	Description	Characteristics Curve
V_{OUT} bandwidth (-3 dB)	f_{-3dB}	The frequency at which the gain drops by -3 dB on input–output frequency dependence against an input sine wave.	-
V_{IN} to V_{OUT} propagation delay time (10%-10%)	t_{PD10}	Propagation delay time from V_{IN} to V_{OUT}. Propagation delay times from 10% of input to 10% of output, from 50% of input to 50% of output, and from 90% of input to 90% of output are specified as t_{PD10}, t_{PD50}, and t_{PD90}, respectively.	
V_{IN} to V_{OUT} propagation delay time (50%-50%)	t_{PD50}		
V_{IN} to V_{OUT} propagation delay time (90%-90%)	t_{PD90}		
V_{OUT} rise time	t_r	Rise time of the differential output voltage V_{OUT+}-V_{OUT-}.	
V_{OUT} fall time	t_f	Fall time of the differential output voltage V_{OUT+}-V_{OUT-}.	
Common-mode transient immunity	CMTI	The maximum tolerable rising or falling rate of input-to-output common-mode voltage at which the prescribed output voltage can be maintained.	-

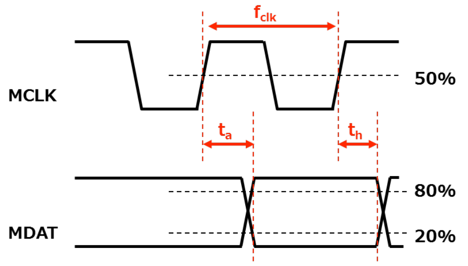
2. Electrical characteristics of digital-output isolation amplifiers

2.1 DC characteristics

Term	Symbol	Description	Characteristics Curve
Integral non-linearity	INL	The maximum deviation of the V_{IN}-MDAT characteristics from the ideal line. INL is expressed in LSB or as a percent (%) of the input range, and specified over the V_{IN} range between -0.2 and +0.2 V. * Ideal line The line that assume output changes with 16bit resolution (65536 step) over the ideal input voltage range(±320 mV) determined by the internal reference voltage V_{IN} (V_{IN+}-V_{IN-}):Differential input voltage MDAT: Digital code output	 (This figure should be considered merely as a guide.)
Differential non-linearity	DNL	The maximum deviation of the actual step width of the V_{IN}-MDAT characteristics from the ideal step width (1 LSB) DNL is expressed in LSB units, and specified over the V_{IN} range between -0.2 and +0.2 V. * Ideal step width (1 LSB) Ideal input voltage range (±320 mV) and output steps(16-bit 65536 step) determine the ideal step width "LSB", 1LSB = 640 mV / 65536 = 9.7 μV=1LSB V_{IN} (V_{IN+}-V_{IN-}):Differential input voltage MDAT: Digital code output	 (This figure should be considered merely as a guide.)
Input offset voltage	V_{OS}	The converted offset voltage obtained by dividing the deviation from the ideal digital code value (32768) at V_{IN}(V_{IN+}-V_{IN-}) of 0V by the gain (1+G_E) with negative coefficient. (Intercept on the V_{IN} axis in the V_{IN}-MDAT curve)	
Input offset voltage drift vs ambient temperature	$\|dV_{OS}/dT_a\|$	The temperature coefficient of the input offset voltage variations (from maximum to minimum value) in ambient temperature range.	
Input offset voltage drift vs input side supply voltage	$\|dV_{OS}/dV_{DD1}\|$	The voltage dependency coefficient of the input offset voltage variations (from maximum to minimum value) in input side supply voltage range.	

Term	Symbol	Description	Characteristics Curve
Internal reference voltage	V_{REF}	The differential input voltage that provides the minimum (0) or maximum (65536) output digital code value in the V_{IN}-MDAT characteristics V_{IN} (V_{IN+}-V_{IN-}):Differential input voltage MDAT: Digital code output	
Gain error	G_E	The percentage (%) of the error of the slope of an approximate straight line from the ideal line (input-to-output gain: 1) in the V_{IN}-MDAT characteristics. G_E is specified over the V_{IN} range between -0.2 and +0.2 V. V_{IN} (V_{IN+}-V_{IN-}):Differential input voltage MDAT: Digital code output	
Input common-mode rejection ratio	$CMRR_{IN}$	The ratio of the gain from a common-mode input (GCM) to the differential input gain (1+G_E). $CMRR_{IN}$ is specified over the V_{IN} range between -0.2 and +0.2 V. $CMRR_{IN}$=20log{(1+G_E)/|GCM|} (dB)	
Signal-to-noise ratio	SNR	The ratio of the level of a desired signal to the level of noise (except harmonics). SNR is specified with a 1kHz, 0.4V_{p-p} sine wave.	
Signal-to-(noise + distortion) ratio	SNDR	The ratio of the level of a desired signal to the level of noise (including harmonics).	
Effective number of bits	ENOB	Signal resolution (effective number of bits) calculated from the SNDR characteristics. ENOB = (SNDR − 1.76)/6.02	
Total harmonic distortion	THD	The ratio of the harmonic components to the fundamental component.	
Input side supply current (V_{DD1})	I_{DD1}	The supply current that flows through the input side when the differential input voltage V_{IN} =(V_{IN+}-V_{IN-}) is 0 V.	-
Output side supply current (V_{DD2})	I_{DD2}	The supply current that flows through the output side when the differential input voltage V_{IN}(V_{IN+}-V_{IN-}) is 0 V.	-
Low-level output voltage	V_{OL}	Minimum voltage of the MDAT and MCLK outputs.	-
High-level output voltage	V_{OH}	Maximum voltage of the MDAT and MCLK outputs.	-
Equivalent input resistance	R_{IN}	Equivalent input resistance over the V_{IN}(V_{IN+}-V_{IN-}) range between -0.2 and +0.2 V.	-

2.2 AC characteristics

Term	Symbol	Description	Characteristics Curve
Output clock frequency	f_{CLK}	The frequency of the clock from the MCLK pin (with a period equal to that of the bitstream data of MDAT pin).	
Access time after MCLK rising edge	t_a	The period of time required for MDAT to finish a High-to-Low or Low-to-High transition from the rising edge of MCLK.	
Hold time after MCLK rising edge	t_h	The period of time required for MDAT to begin a High-to-Low or Low-to-High transition from the rising edge of MCLK.	
Common-mode transient immunity	CMTI	The maximum tolerable rising or falling rate of input-to-output common-mode voltage at which the prescribed output voltage can be maintained.	-

Revision History

Revision	Date	Page	Description
Rev. 1.0	2019/2/18	-	First edition

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