

HIGH SPEED QUAD CHANNEL DIGITAL ISOLATORS

DCL540x01,DCL541x01

DCL540C01/DCL540D01/DCL540L01/DCL540H01/DCL541A01/DCL541B01

1. Applications

- Industrial automation systems
- Motor control
- Inverter
- Switching power supply

2. Description

DCL540C01/DCL540D01/DCL540L01/DCL540H01/DCL541A01/DCL541B01 are quad-channel digital isolators based on Toshiba complementary metal-oxide semiconductor (CMOS) technology. High reinforced insulation is achieved by Toshiba CMOS technology and the magnetic coupling structure. DCL540C01/DCL540D01/DCL540L01/DCL540H01/DCL541A01/DCL541B01 data channels are available in a variety of configuration with a withstand voltage of 5 kVrms. DCL540C01/DCL540D01/DCL540L01/DCL540H01/DCL541A01/DCL541B01 can operate with a temperature range of -40 to 110 °C and a wide supply voltage of 2.25 to 5.5 V.

3. Features

Data rate	: Up to 150 Mbps
Supply voltage	: 2.25 V to 5.5 V
Temperature Range	: -40 °C to 110 °C
Propagation Delay	: 10.9 ns Typical (5.0 V operation)
Default Output	: High and Low Options
High CMTI(min)	: ±100 kV/μs
Withstand Voltage	: 5 kVrms
Package	: 16pin SOIC Wide body

Safety-Related Certification :

UL : UL1577, File No. E519997

cUL : CSA Component Acceptance Service Notice No. 5A, File No. E519997

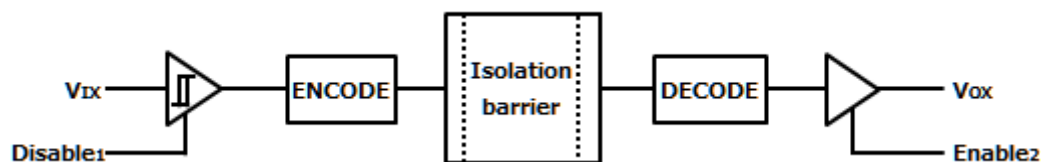
VDE : DIN VDE V 0884-11(VDE V 0884-11) Certificate No. 40055132

CQC : GB 4943.1-2022 Certificate No. CQC22001345018

Table of Contents

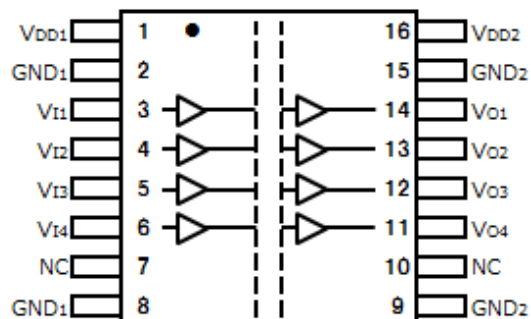
1. Applications	1
2. Description.....	1
3. Features	1
4. Internal Circuit (Simplified Schematic)	3
5. Pin configuration and Functions.....	3
5.1. Pin Functions.....	4
6. Functional Description.....	5
7. Absolute Maximum Ratings	7
8. Recommended Operating Conditions.....	7
9. Electrical Characteristics	8
9.1. Electrical Characteristics – 5 V Supply	8
9.2. Electrical Characteristics – 3.3 V Supply	9
9.3. Electrical Characteristics – 2.5 V Supply	10
9.4. Supply Current Characteristics – 5 V Supply	10
9.5. Supply Current Characteristics – 3.3 V Supply	12
9.6. Supply Current Characteristics – 2.5 V Supply	13
10. Insulation Specifications.....	14
11. Safety Limiting Values.....	15
12. Test Circuit	16
13. Characteristics Curves	27
14. Application Note	29
14.1. Eye diagram	29
14.2. PCB layout.....	29
15. Package Information	30
RESTRICTIONS ON PRODUCT USE.....	31

4. Internal Circuit (Simplified Schematic)

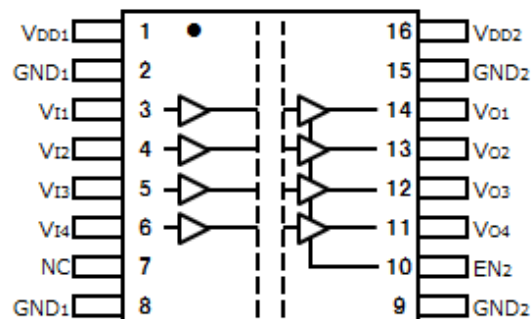


5. Pin configuration and Functions

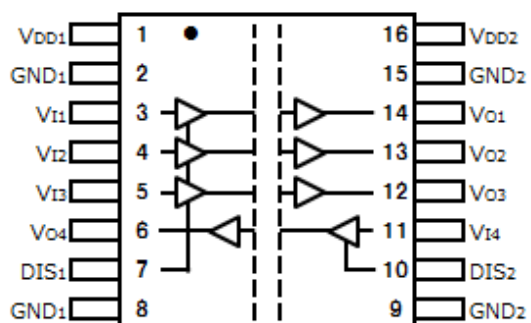
DCL540C01 / DCL540D01



DCL540L01 / DCL540H01



DCL541A01 / DCL541B01



5.1. Pin Functions

NAME	PIN			I/O	DESCRIPTION
	DCL540 C01 / D01	DCL540 L01 / H01	DCL541 A01 / B01		
VDD ₁	1	1	1	-	Power Supply, side 1
GND ₁	2	2	2	-	GND connection for VDD ₁ , side 1
V _{I1}	3	3	3	I	Input, Channel1
V _{I2}	4	4	4	I	Input, Channel2
V _{I3}	5	5	5	I	Input, Channel3
V _{I4}	6	6	11	I	Input, Channel4
NC	7	7	-	-	Non connected
DIS ₁	-	-	7	I	Input disable 1. Input pins on side 1 are disabled when DIS ₁ is high, and in enabled state when DIS ₁ is low or open.
GND ₁	8	8	8	-	GND connection for VDD ₁ , side 1
GND ₂	9	9	9	-	GND connection for VDD ₂ , side 2
DIS ₂	-	-	10	I	Input disable 2. Input pins on side 2 are disabled when DIS ₂ is high, and in enabled state when DIS ₂ is low or open.
EN ₂	-	10	-	I	Input enable 2. Input pins on side 2 are enabled when EN ₂ is high or open, and in high impedance state when EN ₂ is low.
NC	10	-	-	-	Non connected
V _{O4}	11	11	6	O	Output, Channel4
V _{O3}	12	12	12	O	Output, Channel3
V _{O2}	13	13	13	O	Output, Channel2
V _{O1}	14	14	14	O	Output, Channel1
GND ₂	15	15	15	-	GND connection for VDD ₂ , side 2
VDD ₂	16	16	16	-	Power Supply, side 2

6. Functional Description

(1) DCL540C01/ DCL540D01

VDD ₁	VDD ₂	INPUT (V _{ix})	OUTPUT (V _{Ox})	COMMENTS
PU	PU	L	L	Normal Operation
		H	H	
		OPEN	Default	Default mode DCL540C01=L , DCL540D01=H
PD		L or OPEN		
PU	PD	X	Undetermined	When VDD ₂ is unpowered, a channel output is undetermined.
PD		L or OPEN		
PD	X	H	-	Don't use, since a certain voltage will be output through the internal ESD circuit.

PU= Powered up (VDD₂≥2.25 V), PD= Powered down (VDD₂≤1.7 V), H= High level, L= Low level, X= Don't care

(2) DCL540L01/ DCL540H01

VDD ₁	VDD ₂	OUTPUT ENABLE (EN ₂)	INPUT (V _{ix})	OUTPUT (V _{Ox})	COMMENTS
PU	PU	H or OPEN	L	L	Normal Operation
			H	H	
			OPEN	Default	Default mode DCL540L01=L , DCL540H01=H
		L	X	Z	Output Disable mode
PD	PU	H or OPEN	L or OPEN	Default	Default mode DCL540L01=L , DCL540H01=H
		L		Z	Output Disable mode
	X	X	H	-	Don't use, since a certain voltage will be output through the internal ESD circuit.
PU	PD	L or OPEN	X	Undetermined	When VDD ₂ is unpowered, a channel output is undetermined.
PD			L or OPEN		
X		H	X	-	Don't use, since a certain voltage will be output through the internal ESD circuit.

PU= Powered up (VDD₂≥2.25 V), PD= Powered down (VDD₂≤1.7 V), H= High level, L= Low level, X= Don't care

(3) DCL541A01/ DCL541B01

V _{DD1}	V _{DD2}	INPUT DISABLE (DIS _x)	INPUT (V _{ix})	OUTPUT (V _{ox})	COMMENTS
PU	PU	L or OPEN	L	L	Normal Operation
			H	H	
		OPEN		Default	Default mode DCL541A01=L , DCL541B01=H
		H	X		Input Disable mode DCL541A01=L , DCL541B01=H
	PD	X	X	Undetermined	When V _{DD2} is unpowered, a channel output is undetermined.
PD	X	H	X	Don't use	Don't use, since a certain voltage will be output through the internal ESD circuit.
		X	H		
	PU	L or OPEN	L or OPEN	Default	Default mode DCL541A01=L , DCL541B01=H
	PD			Undetermined	When V _{DD2} is unpowered, a channel output is undetermined.

V_{DD1}: Input V_{DDx} , V_{DD0}: Output V_{DDx} , PU= Powered up (V_{DD}≥2.25 V), PD=Powered down (V_{DD}≤1.7 V),
H=High Level, L=Low Level, X= Don't care

7. Absolute Maximum Ratings (T_a = 25 °C)

PARAMETER	SYMBOL	MIN	MAX	UNIT
Power supply voltage	V _{DD1} , V _{DD2}	-0.5	6.0	V
Input Voltage	V _I	-0.5	V _{DDX} +0.5 ⁽¹⁾	V
Output Voltage	V _O	-0.5	V _{DDX} +0.5 ⁽¹⁾	V
Output Current	I _O	-15	15	mA
Storage Temperature	T _{stg}	-65	150	°C
Operating Temperature	T _{opr}	-40	110	°C
Soldering Temperature (10 s)	T _{sol}	-	260	°C
Maximum Withstanding Isolation Voltage (1 min.)	BV _S	5000	-	V _{rms}

Note(1): Maximum voltage must not exceed 6 V. X = 1 or 2.

8. Recommended Operating Conditions (Note)

PARAMETER	SYMBOL	MIN	MAX	UNIT
Power supply voltage	V _{DD1} , V _{DD2}	2.25	5.5	V
Junction Temperature	T _J	-40	150	°C
Ambient Temperature	T _a	-40	110	°C

Note: The recommended operating conditions are given as a design guide necessary to obtain the intended performance of the device. Each parameter is an independent value. When creating a system design using this device, the electrical characteristics specified in this data sheet should also be considered.

Note: A ceramic capacitor (0.1 μF) should be connected between pin 1 (V_{DD1}) and pin 2 (GND₁) for VDD1 and between pin 16 (V_{DD2}) and pin 15 (GND₂) for VDD2, and should be the layout on the IC as close as possible (less than 10 mm).

Otherwise, the IC may not switch properly.

9. Electrical Characteristics

9.1. Electrical Characteristics – 5 V Supply

All typical specifications are at $T_a=25\text{ }^{\circ}\text{C}$, $V_{DD1}=V_{DD2}=5\text{ V}$. Minimum/maximum specifications apply over the entire recommended operating range of $4.5\text{ V}\leq V_{DD1}\leq 5.5\text{ V}$, $4.5\text{ V}\leq V_{DD2}\leq 5.5\text{ V}$, and $-40\text{ }^{\circ}\text{C}\leq T_a\leq 110\text{ }^{\circ}\text{C}$, unless otherwise noted.

PARAMETER	TEST CONDITIONS	Fig.	SYMBOL	MIN	TYP.	MAX	UNIT
DC SPECIFICATIONS							
Under voltage Lockout	Threshold when supply voltage is rising	12-1	V_{DDxUV+}	-	2.1	2.25	V
	Threshold when supply voltage is falling		V_{DDxUV-}	1.7	1.9	-	
	Supply voltage hysteresis		V_{DDxUVH}	0.1	0.2	-	
Output Voltage Logic High	$V_{IX}=H$, $I_{OH}=-20\text{ }\mu\text{A}$	12-2	V_{OH}	$V_{DDO}^{(1)}-0.1$	$V_{DDO}^{(1)}$	-	V
	$V_{IX}=H$, $I_{OH}=-4\text{ mA}$			$V_{DDO}^{(1)}-0.4$	$V_{DDO}^{(1)}-0.2$	-	
Output Voltage Logic Low	$V_{IX}=L$, $I_{OL}=20\text{ }\mu\text{A}$	12-2	V_{OL}	-	0.0	0.1	V
	$V_{IX}=L$, $I_{OL}=4\text{ mA}$			-	0.2	0.4	
Output impedance	-	12-2	Z_O	-	50	-	Ω
High-level input voltage	-	12-3	V_{IH}	$0.7*V_{DDI}^{(1)}$	-	-	V
Low-level input voltage	-	12-3	V_{IL}	-	-	$0.3*V_{DDI}^{(1)}$	V
Input Voltage Hysteresis	-	12-3	V_{HYS}	-	0.37	-	V
Input Current	$V_I=V_{DDI}^{(1)}$ or 0 V	-	I_I	-	-	± 10	μA
SWITCHING SPECIFICATIONS							
Data Rate	-	-	t_{bps}	DC	-	150	Mbps
Pulse Width	-	-	PW	6.6	-	-	ns
Propagation Delay	50 kHz, Duty=50 %, $t_r=t_f=2\text{ ns}$, $C_L=15\text{ pF}$	12-4	t_{PHL} , t_{PLH}	-	10.9	18.3	ns
Pulse Width Distortion	$ t_{PHL} - t_{PLH} $	12-4	PWD	-	0.8	2.8	ns
Propagation Delay Skew (Between any two units)	Note (2)	-	t_{PSK}	-	-	10	ns
Channel Matching	Same Direction	12-4	t_{skCD}	-	-	3.2	ns
	Opposing Direction	12-4	t_{skOD}	-	-	3.6	
Output Rise Time	10 % - 90 %	12-4	t_r	-	0.9	-	ns
Output Fall Time	90 % - 10 %	12-4	t_f	-	0.9	-	ns
Enable 3-state output enable time	50 kHz, Duty=50 %, $t_r=t_f=2\text{ ns}$, $C_L=15\text{ pF}$	12-5	t_{pZL} , t_{pZH}	-	-	15.0	ns
Enable 3-state output disable time	Note (3)	12-5	t_{pLZ} , t_{pHZ}	-	-	18.0	ns
Disable output enable time	50 kHz, Duty=50 %, $t_r=t_f=2\text{ ns}$, $C_L=15\text{ pF}$	12-6	t_{p_EN}	-	-	23.0	ns
Disable output disable time		12-6	t_{p_DIS}	-	-	23.0	ns
Common mode transient immunity	VCM=1500 V	12-7	CMTI	100	-	-	kV/ μs

Note (1) V_{DDI} =Input-side V_{DDx} , V_{DDO} =Output-side V_{DDx} .

Note (2) Propagation delay difference (between parts) is applied under the same operating conditions (power supply voltage, input current, temperature conditions, etc.).

Note (3) When EN_2 signal is changed from Low to High or OPEN, the output signal(V_{OX}) is valid after the output enable time. The output signal(V_{OX}) within the output enable time is undefined.

9.2. Electrical Characteristics – 3.3 V Supply

All typical specifications are at $T_a=25\text{ }^{\circ}\text{C}$, $V_{DD1}=V_{DD2}=3.3\text{ V}$. Minimum/maximum specifications apply over the entire recommended operating range of $3.0\text{ V}\leq V_{DD1}\leq 3.6\text{ V}$, $3.0\text{ V}\leq V_{DD2}\leq 3.6\text{ V}$, and $-40\text{ }^{\circ}\text{C}\leq T_a\leq 110\text{ }^{\circ}\text{C}$, unless otherwise noted.

PARAMETER	TEST CONDITIONS	Fig.	SYMBOL	MIN	TYP.	MAX	UNIT
DC SPECIFICATIONS							
Under voltage Lockout	Threshold when supply voltage is rising	12-1	V_{DDxUV+}	-	2.1	2.25	V
	Threshold when supply voltage is falling		V_{DDxUV-}	1.7	1.9	-	
	Supply voltage hysteresis		V_{DDxUVH}	0.1	0.2	-	
Output Voltage Logic High	$V_{ix}=H$, $I_{OH}=-20\text{ }\mu\text{A}$	12-2	V_{OH}	$V_{DDO(1)}-0.1$	$V_{DDO(1)}$	-	V
	$V_{ix}=H$, $I_{OH}=-4\text{ mA}$			$V_{DDO(1)}-0.4$	$V_{DDO(1)}-0.2$	-	
Output Voltage Logic Low	$V_{ix}=L$, $I_{OL}=20\text{ }\mu\text{A}$	12-2	V_{OL}	-	0.0	0.1	V
	$V_{ix}=L$, $I_{OL}=4\text{ mA}$			-	0.2	0.4	
Output impedance	-	12-2	Z_O	-	50	-	Ω
High-level input voltage	-	12-3	V_{IH}	$0.7*V_{DDI(1)}$	-	-	V
Low-level input voltage	-	12-3	V_{IL}	-	-	$0.3*V_{DDI(1)}$	V
Input Voltage Hysteresis	-	12-3	V_{HYS}	-	0.32	-	V
Input Current	$V_I=V_{DDI(1)}$ or 0 V	-	I_I	-	-	± 10	μA
SWITCHING SPECIFICATIONS							
Data Rate	-	-	t_{bps}	DC	-	150	Mbps
Pulse Width	-	-	PW	6.6	-	-	ns
Propagation Delay	50 kHz,Duty=50 %, $t_r=t_f=2\text{ ns}$, $C_L=15\text{ pF}$	12-4	t_{PHL} , t_{PLH}	-	11.6	19.1	ns
Pulse Width Distortion	$ t_{PHL} - t_{PLH} $	12-4	PWD	-	0.8	2.8	ns
Propagation Delay Skew (Between any two units)	Note (2)	-	t_{PSK}	-	-	10	ns
Channel Matching	Same Direction	12-4	t_{skCD}	-	-	3.3	ns
	Opposing Direction	12-4	t_{skOD}	-	-	3.7	
Output Rise Time	10 % - 90 %	12-4	t_r	-	0.8	-	ns
Output Fall Time	90 % - 10 %	12-4	t_f	-	0.8	-	ns
Enable 3-state output enable time	50 kHz, Duty=50 %, $t_r=t_f=2\text{ ns}$, $C_L=15\text{ pF}$	12-5	t_{pZL} , t_{pZH}	-	-	15.0	ns
Enable 3-state output disable time	Note (3)	12-5	t_{pLZ} , t_{pHZ}	-	-	18.0	ns
Disable output enable time	50 kHz, Duty=50 %, $t_r=t_f=2\text{ ns}$, $C_L=15\text{ pF}$	12-6	t_{p_EN}	-	-	23.0	ns
Disable output disable time		12-6	t_{p_DIS}	-	-	23.0	ns
Common mode transient immunity	VCM=1500 V	12-7	CMTI	100	-	-	kV/ μs

Note (1) V_{DDI} =Input-side V_{DDx} , V_{DDO} =Output-side V_{DDx}

Note (2) Propagation delay difference (between parts) is applied under the same operating conditions (power supply voltage, input current, temperature conditions, etc)..

Note (3) When EN_2 signal is changed from Low to High or OPEN, the output signal(V_{OX}) is valid after the output enable time. The output signal(V_{OX}) within the output enable time is undefined)

9.3. Electrical Characteristics – 2.5 V Supply

All typical specifications are at $T_a=25\text{ }^{\circ}\text{C}$, $V_{DD1}=V_{DD2}=2.5\text{ V}$. Minimum/maximum specifications apply over the entire recommended operating range of $2.25\text{ V}\leq V_{DD1}\leq 2.75\text{ V}$, $2.25\text{ V}\leq V_{DD2}\leq 2.75\text{ V}$, and $-40\text{ }^{\circ}\text{C}\leq T_a\leq 110\text{ }^{\circ}\text{C}$, unless otherwise noted.

PARAMETER	TEST CONDITIONS	Fig.	SYMBOL	MIN	TYP.	MAX	UNIT
DC SPECIFICATIONS							
Under voltage Lockout	Threshold when supply voltage is rising	12-1	V_{DDxUV+}	-	2.1	2.25	V
	Threshold when supply voltage is falling		V_{DDxUV-}	1.7	1.9	-	
	Supply voltage hysteresis		V_{DDxUVH}	0.1	0.2	-	
Output Voltage Logic High	$V_{ix}=H$, $I_{OH}=-20\text{ }\mu\text{A}$	12-2	V_{OH}	$V_{DDO(1)}-0.1$	$V_{DDO(1)}$	-	V
	$V_{ix}=H$, $I_{OH}=-4\text{ mA}$			$V_{DDO(1)}-0.4$	$V_{DDO(1)}-0.2$	-	
Output Voltage Logic Low	$V_{ix}=L$, $I_{OL}=20\text{ }\mu\text{A}$	12-2	V_{OL}	-	0.0	0.1	V
	$V_{ix}=L$, $I_{OL}=4\text{ mA}$			-	0.2	0.4	
Output impedance	-	12-2	Z_o	-	50	-	Ω
High-level input voltage	-	12-3	V_{IH}	$0.7*V_{DDI(1)}$	-	-	V
Low-level input voltage	-	12-3	V_{IL}	-	-	$0.3*V_{DDI(1)}$	V
Input Voltage Hysteresis	-	12-3	V_{HYS}	-	0.32	-	V
Input Current	$V_i=V_{DDI(1)}$ or 0 V	-	I_i	-	-	± 10	μA
SWITCHING SPECIFICATIONS							
Data Rate	-	-	t_{bps}	DC	-	150	Mbps
Pulse Width	-	-	PW	6.6	-	-	ns
Propagation Delay	50 kHz, Duty=50 %, $t_r=t_f=2\text{ ns}$, $C_L=15\text{ pF}$	12-4	t_{PHL} , t_{PLH}	-	12.6	21.0	ns
Pulse Width Distortion	$ t_{PHL} - t_{PLH} $	12-4	PWD	-	1.0	3.0	ns
Propagation Delay Skew (Between any two units)	Note (2)	-	t_{PSK}	-	-	10	ns
Channel Matching	Same Direction	12-4	t_{skCD}	-	-	3.5	ns
	Opposing Direction	12-4	t_{skOD}	-	-	3.9	
Output Rise Time	10 % - 90 %	12-4	t_r	-	0.8	-	ns
Output Fall Time	90 % - 10 %	12-4	t_f	-	0.8	-	ns
Enable 3-state output enable time	50 kHz, Duty=50 %, $t_r=t_f=2\text{ ns}$, $C_L=15\text{ pF}$	12-5	t_{pZL} , t_{pZH}	-	-	15.0	ns
Enable 3-state output disable time	Note (3)	12-5	t_{pLZ} , t_{pHZ}	-	-	18.0	ns
Disable output enable time	50 kHz, Duty=50 %, $t_r=t_f=2\text{ ns}$, $C_L=15\text{ pF}$	12-6	t_{p_EN}	-	-	23.0	ns
Disable output disable time		12-6	t_{p_DIS}	-	-	23.0	ns
Common mode transient immunity	$V_{CM}=1500\text{ V}$	12-7	CMTI	100	-	-	kV/ μs

Note (1) V_{DDI} =Input-side V_{DDx} , V_{DDO} =Output-side V_{DDx}

Note (2) Propagation delay difference (between parts) is applied under the same operating conditions (power supply voltage, input current, temperature conditions, etc)..

Note (3) When EN_2 signal is changed from Low to High or OPEN, the output signal(V_{Ox}) is valid after the output enable time. The output signal(V_{Ox}) within the output enable time is undefined)

9.4. Supply Current Characteristics – 5 V Supply

All typical specifications are at $T_a=25\text{ }^{\circ}\text{C}$, $V_{DD1}=V_{DD2}=5\text{ V}$. Minimum/maximum specifications apply over the entire recommended operating range of $4.5\text{ V}\leq V_{DD1}\leq 5.5\text{ V}$, $4.5\text{ V}\leq V_{DD2}\leq 5.5\text{ V}$, and $-40\text{ }^{\circ}\text{C}\leq T_a\leq 110\text{ }^{\circ}\text{C}$, unless otherwise noted.

(1) DCL540x01

PARAMETER	TEST CONDITIONS	SYMBOL	MIN	TYP.	MAX	UNIT
Supply Current (DC Signal)	$V_I=0$ (DCL540C01 , DCL540L01) , $V_I=1$ (DCL540D01 , DCL540H01)	$I_{DD1(Q)}$	-	2.1	3.0	mA
		$I_{DD2(Q)}$	-	5.0	7.3	mA
	$V_I=0$ (DCL540D01 , DCL540H01) , $V_I=1$ (DCL540C01 , DCL540L01)	$I_{DD1(Q)}$	-	19.6	28.1	mA
		$I_{DD2(Q)}$	-	5.3	7.6	mA
1 Mbps	$f_{CLK}=500\text{ kHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(1)}$	-	11.2	17.5	mA
		$I_{DD2(1)}$	-	5.4	8.3	mA
25 Mbps	$f_{CLK}=12.5\text{ MHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(25)}$	-	11.0	17.1	mA
		$I_{DD2(25)}$	-	9.8	14.7	mA
100 Mbps	$f_{CLK}=50\text{ MHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(100)}$	-	12.4	18.4	mA
		$I_{DD2(100)}$	-	25.2	37.1	mA

(2) DCL541x01

PARAMETER	TEST CONDITIONS	SYMBOL	MIN	TYP.	MAX	UNIT
Supply Current (DC Signal)	$V_I=0$ (DCL541A01) , $V_I=1$ (DCL541B01)	$I_{DD1(Q)}$	-	3.0	4.3	mA
		$I_{DD2(Q)}$	-	4.5	6.6	mA
	$V_I=0$ (DCL541B01) , $V_I=1$ (DCL541A01)	$I_{DD1(Q)}$	-	16.6	22.5	mA
		$I_{DD2(Q)}$	-	10.2	14.1	mA
1 Mbps	$f_{CLK}=500\text{ kHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(1)}$	-	10.0	15.5	mA
		$I_{DD2(1)}$	-	7.6	10.2	mA
25 Mbps	$f_{CLK}=12.5\text{ MHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(25)}$	-	12.1	18.2	mA
		$I_{DD2(25)}$	-	10.6	15.4	mA
100 Mbps	$f_{CLK}=50\text{ MHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(100)}$	-	17.4	24.5	mA
		$I_{DD2(100)}$	-	22.5	35.2	mA

9.5. Supply Current Characteristics – 3.3 V Supply

All typical specifications are at $T_a=25\text{ }^{\circ}\text{C}$, $V_{DD1}=V_{DD2}=3.3\text{ V}$. Minimum/maximum specifications apply over the entire recommended operating range of $3.0\text{ V}\leq V_{DD1}\leq 3.6\text{ V}$, $3.0\text{ V}\leq V_{DD2}\leq 3.6\text{ V}$, and $-40\text{ }^{\circ}\text{C}\leq T_a\leq 110\text{ }^{\circ}\text{C}$, unless otherwise noted.

(1) DCL540x01

PARAMETER	TEST CONDITIONS	SYMBOL	MIN	TYP.	MAX	UNIT
Supply Current (DC Signal)	$V_I=0$ (DCL540C01 , DCL540L01) , $V_I=1$ (DCL540D01 , DCL540H01)	$I_{DD1(Q)}$	-	2.0	2.9	mA
		$I_{DD2(Q)}$	-	4.9	7.1	mA
	$V_I=0$ (DCL540D01 , DCL540H01) , $V_I=1$ (DCL540C01 , DCL540L01)	$I_{DD1(Q)}$	-	19.4	27.7	mA
		$I_{DD2(Q)}$	-	5.2	7.4	mA
1 Mbps	$f_{CLK}=500\text{ kHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(1)}$	-	11.0	16.7	mA
		$I_{DD2(1)}$	-	5.2	7.8	mA
25 Mbps	$f_{CLK}=12.5\text{ MHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(25)}$	-	10.6	16.0	mA
		$I_{DD2(25)}$	-	8.2	12.4	mA
100 Mbps	$f_{CLK}=50\text{ MHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(100)}$	-	11.6	16.6	mA
		$I_{DD2(100)}$	-	16.5	29.3	mA

(2) DCL541x01

PARAMETER	TEST CONDITIONS	SYMBOL	MIN	TYP.	MAX	UNIT
Supply Current (DC Signal)	$V_I=0$ (DCL541A01) , $V_I=1$ (DCL541B01)	$I_{DD1(Q)}$	-	2.9	4.1	mA
		$I_{DD2(Q)}$	-	4.4	6.5	mA
	$V_I=0$ (DCL541B01) , $V_I=1$ (DCL541A01)	$I_{DD1(Q)}$	-	16.5	22.3	mA
		$I_{DD2(Q)}$	-	10.1	14.0	mA
1 Mbps	$f_{CLK}=500\text{ kHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(1)}$	-	9.9	14.9	mA
		$I_{DD2(1)}$	-	7.5	9.5	mA
25 Mbps	$f_{CLK}=12.5\text{ MHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(25)}$	-	10.8	16.6	mA
		$I_{DD2(25)}$	-	9.7	12.8	mA
100 Mbps	$f_{CLK}=50\text{ MHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(100)}$	-	14.5	19.9	mA
		$I_{DD2(100)}$	-	16.6	26.0	mA

9.6. Supply Current Characteristics – 2.5 V Supply

All typical specifications are at $T_a=25\text{ }^{\circ}\text{C}$, $V_{DD1}=V_{DD2}=2.5\text{ V}$. Minimum/maximum specifications apply over the entire recommended operating range of $2.25\text{ V}\leq V_{DD1}\leq 2.75\text{ V}$, $2.25\text{ V}\leq V_{DD2}\leq 2.75\text{ V}$, and $-40\text{ }^{\circ}\text{C}\leq T_a\leq 110\text{ }^{\circ}\text{C}$, unless otherwise noted

(1) DCL540x01

PARAMETER	TEST CONDITIONS	SYMBOL	MIN	TYP.	MAX	UNIT
Supply Current (DC Signal)	$V_I=0(\text{DCL541A01})$, $V_I=1(\text{DCL541B01})$	$I_{DD1(Q)}$	-	1.9	2.8	mA
		$I_{DD2(Q)}$	-	4.9	7.0	mA
	$V_I=0(\text{DCL541B01})$, $V_I=1(\text{DCL541A01})$	$I_{DD1(Q)}$	-	19.3	27.6	mA
		$I_{DD2(Q)}$	-	5.2	7.3	mA
1 Mbps	$f_{CLK}=50\text{ MHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(1)}$	-	11.0	16.6	mA
		$I_{DD2(1)}$	-	5.2	7.7	mA
25 Mbps	$f_{CLK}=500\text{ kHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(25)}$	-	10.4	15.8	mA
		$I_{DD2(25)}$	-	7.5	11.6	mA
100 Mbps	$f_{CLK}=12.5\text{ MHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(100)}$	-	11.5	16.3	mA
		$I_{DD2(100)}$	-	13.6	25.8	mA

(2) DCL541x01

PARAMETER	TEST CONDITIONS	SYMBOL	MIN	TYP.	MAX	UNIT
Supply Current (DC Signal)	$V_I=0(\text{DCL541A01})$, $V_I=1(\text{DCL541B01})$	$I_{DD1(Q)}$	-	2.9	4.1	mA
		$I_{DD2(Q)}$	-	4.5	6.4	mA
	$V_I=0(\text{DCL541B01})$, $V_I=1(\text{DCL541A01})$	$I_{DD1(Q)}$	-	16.4	22.2	mA
		$I_{DD2(Q)}$	-	10.0	13.9	mA
1 Mbps	$f_{CLK}=500\text{ kHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(1)}$	-	9.8	14.8	mA
		$I_{DD2(1)}$	-	7.4	9.5	mA
25 Mbps	$f_{CLK}=12.5\text{ MHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(25)}$	-	10.4	16.1	mA
		$I_{DD2(25)}$	-	9.2	12.2	mA
100 Mbps	$f_{CLK}=50\text{ MHz}$, duty=50 % cycle square wave. $C_L=15\text{ pF}$	$I_{DD1(100)}$	-	13.1	18.2	mA
		$I_{DD2(100)}$	-	14.3	24.1	mA

10. Insulation Specifications

PARAMETER	Symbol	TEST CONDITIONS	VALUE	UNIT
Minimum External Clearance	CLR	-	8	mm
Minimum External Creepage	CPG	-	8	mm
Distance Through The Insulation	DTI	-	17	μm
Comparative Tracking Index	CTI	-	400	V
Material Group	-	According to IEC 60664-1	II	-
Overvoltage Category Per IEC 60664-1	-	Related Mains Voltage $\leq 300 V_{RMS}$	I-IV	-
	-	Related Mains Voltage $\leq 600 V_{RMS}$	I-IV	-
	-	Related Mains Voltage $\leq 1000 V_{RMS}$	I-III	-
DIN VDE V 0884-11(VDE V 0884-11)				
Maximum Repetitive Peak Isolation Voltage	V_{IORM}	AC voltage (bipolar)	1414	V_{PK}
Maximum Transient Isolation Voltage	V_{IOTM}	$V_{TEST} = V_{IOTM}$, $t = 60$ s (qualification) , $V_{TEST} = V_{IOTM}$, $t = 1$ s (100 % production)	8000	V_{PK}
Maximum surge isolation voltage	V_{IOSM}	Test method per IEC 60065, 1.2/50 μs waveform, $V_{TEST} = 1.6 \times V_{IOSM}$ (qualification)	8000	V_{PK}
Apparent charge measuring voltage	$V_{pd(m)}$	Method A, After Input/Output safety test subgroup2&3, $V_{IORM} \times 1.2 = V_{pd}$ (m), $t_{ini} = 60$ sec, $t_m = 10$ sec, partial discharge < 5 pC	1697	V_{PK}
		Method A, After environmental tests subgroup 1, $V_{IORM} \times 1.6 = V_{pd}$ (m), $t_{ini} = 60$ sec, $t_m = 10$ sec, partial discharge < 5 pC	2263	
		Method B2; At routine test (100 % production) and preconditioning (type test) $V_{IORM} \times 1.875 = V_{pd}$ (m), 100 % production test, $t_{ini} = t_m = 1$ sec, partial discharge < 5 pC	2652	
Barrier capacitance, input to output	C_{IO}	$f = 1$ MHz	1.5	pF
Input Capacitance	C_I	V_{IX}	1.8	pF
Isolation Resistance	R_{IO}	$V_{IO} = 500$ V, $T_A = 25$ °C	$>10^{12}$	Ω
		$V_{IO} = 500$ V, 100 °C $\leq T_A \leq 110$ °C	$>10^{11}$	
		$V_{IO} = 500$ V at $T_S = 150$ °C	$>10^9$	
Pollution Degree	-	-	2	-
Climatic Category	-	-	40/110/21	-
UL 1577				
Maximum Withstanding Isolation Voltage	V_{ISO}	$V_{TEST} = V_{ISO}$, $t = 60$ s (qualification), $V_{TEST} = 1.2 \times V_{ISO}$, $t = 1$ s (100 % production)	5000	V_{RMS}

11. Safety Limiting Values

PARAMETER	Symbol	TEST CONDITIONS	Value	Unit
Safety Input, Output Or Supply Current	I_S	VDD1=VDD2=5.5 V, $T_j=150\text{ }^{\circ}\text{C}$, $T_a=25\text{ }^{\circ}\text{C}$	284	mA
		VDD1=VDD2=3.6 V, $T_j=150\text{ }^{\circ}\text{C}$, $T_a=25\text{ }^{\circ}\text{C}$	434	mA
		VDD1=VDD2=2.75 V, $T_j=150\text{ }^{\circ}\text{C}$, $T_a=25\text{ }^{\circ}\text{C}$	568	mA
Safety Input, Output Or Total Power	P_S	$T_j=150\text{ }^{\circ}\text{C}$, $T_a=25\text{ }^{\circ}\text{C}$	1562	mW
Maximum Safety Temperature	T_S	-	150	$^{\circ}\text{C}$

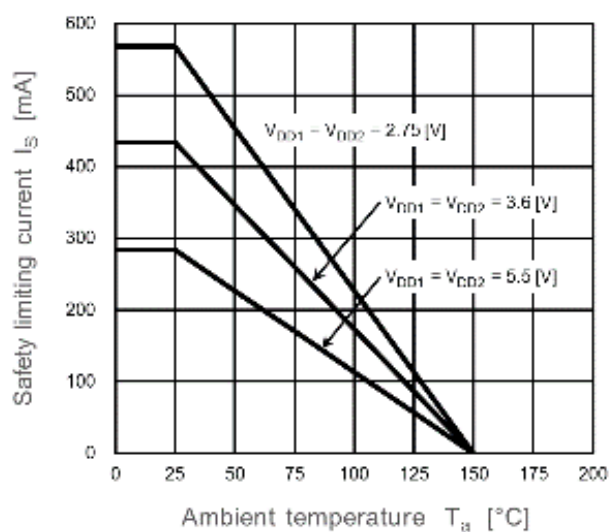
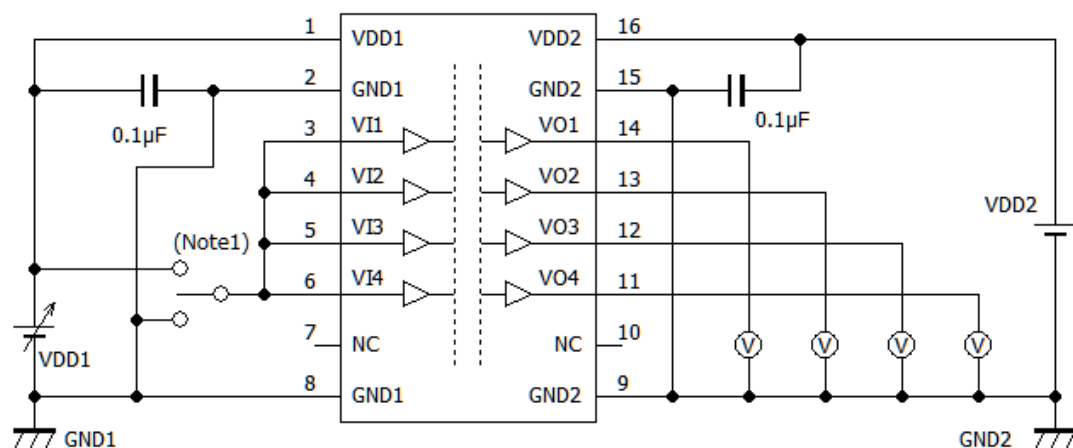


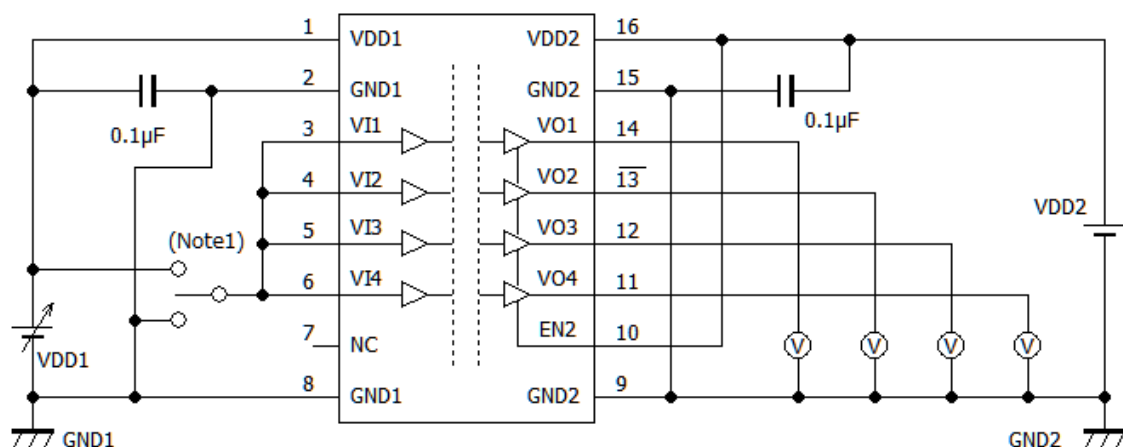
Fig. 11-1. Thermal Derating Curve for Safety Limiting Current— T_a

12. Test Circuit



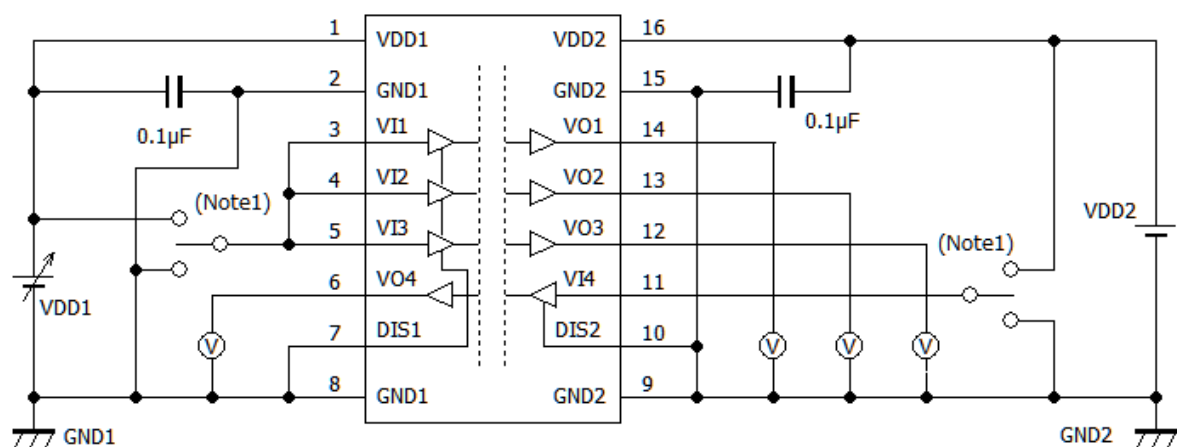
(Note 1) Default=L : V_{DD1} , Default=H : GND_1

Fig.12-1-1. DCL540C01/DCL540D01 V_{DD1UV+}/V_{DD1UV-} Test Circuit



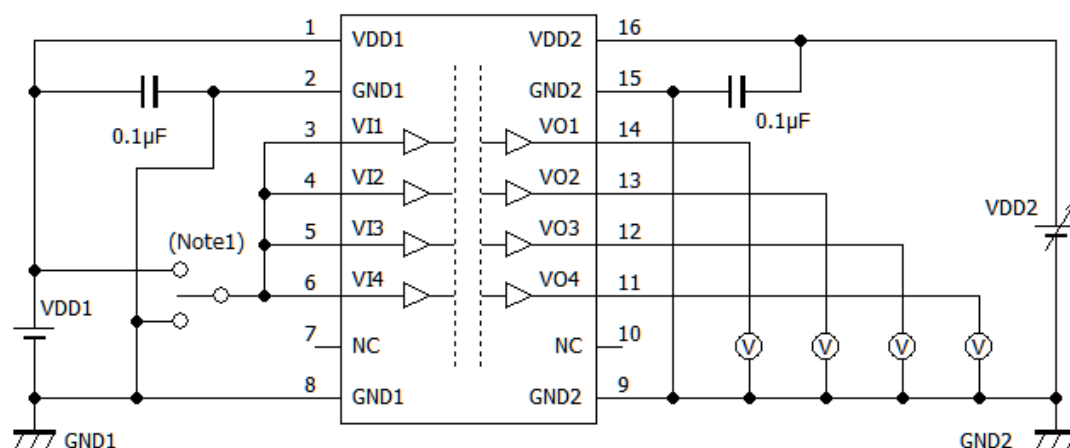
(Note 1) Default=L : V_{DD1} , Default=H : GND_1

Fig.12-1-2. DCL540L01/DCL540H01 V_{DD1UV+}/V_{DD1UV-} Test Circuit



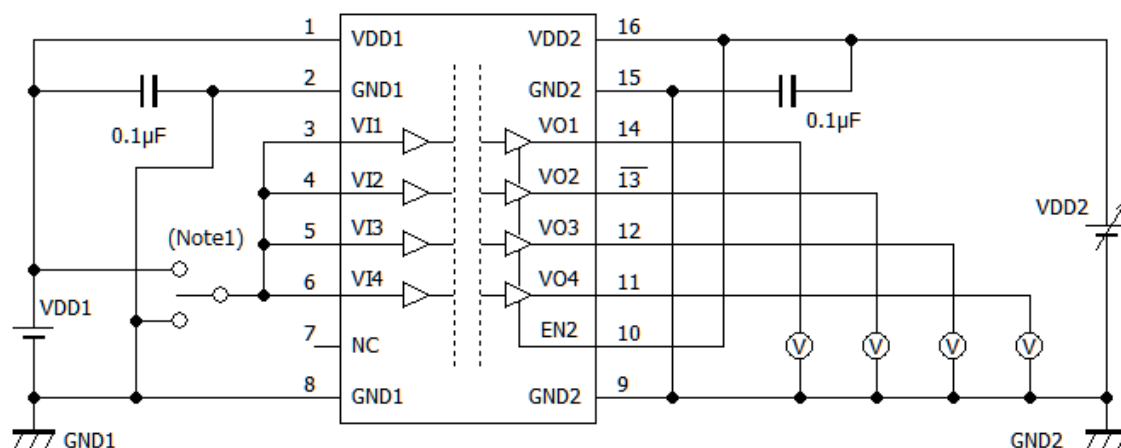
(Note 1) Default=L : V_{DD1} , Default=H : GND_1

Fig.12-1-3. DCL541A01/DCL541B01 V_{DD1UV+}/V_{DD1UV-} Test Circuit



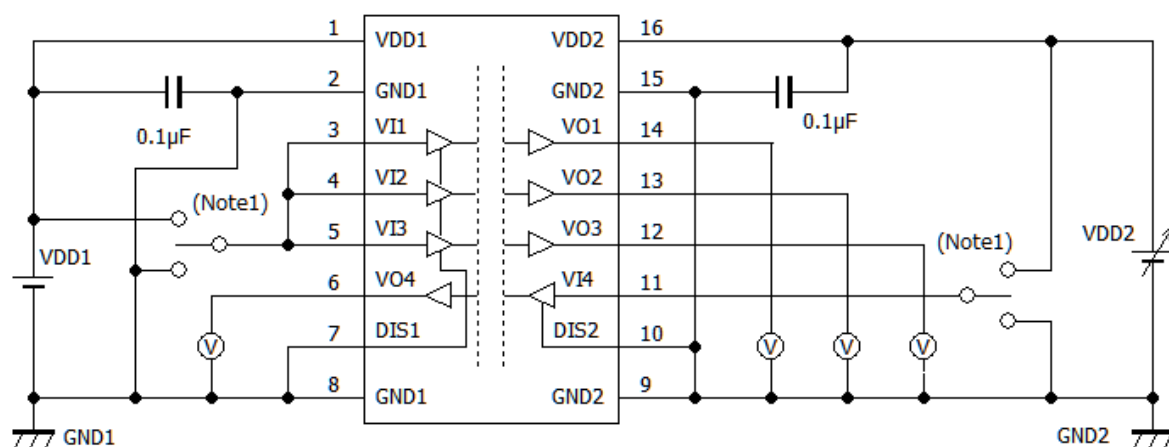
(Note 1) Default=L : VDD1 , Default=H : GND1

Fig.12-1-4. DCL540C01/DCL540D01 VDD2_{UV+}/ VDD2_{UV} Test Circuit



(Note 1) Default=L : VDD1 , Default=H : GND1

Fig.12-1-5. DCL540L01/DCL540H01 VDD2_{UV+}/ VDD2_{UV} Test Circuit



(Note 1) Default=L : VDD1 , Default=H : GND

Fig.12-1-6. DCL541A01/DCL541B01 VDD2_{UV+}/ VDD2_{UV} Test Circuit

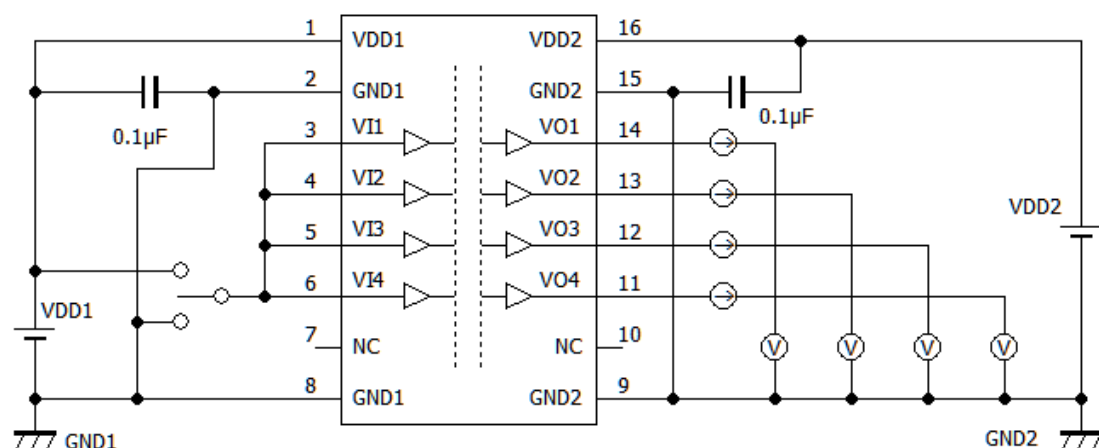


Fig.12-2-1. DCL540C01/DCL540D01 VOH/VOL Test Circuit

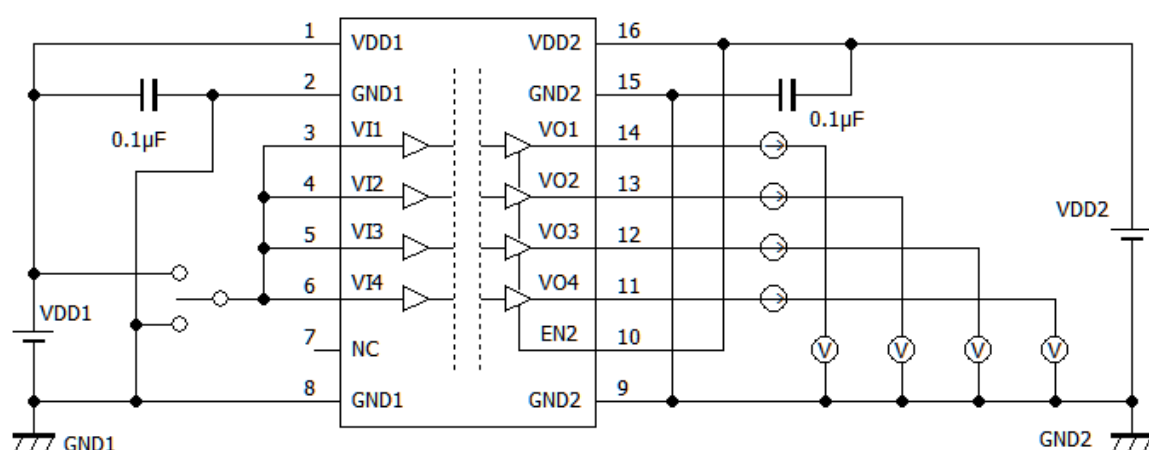


Fig.12-2-2. DCL540L01/DCL540H01 VOH/VOL Test Circuit

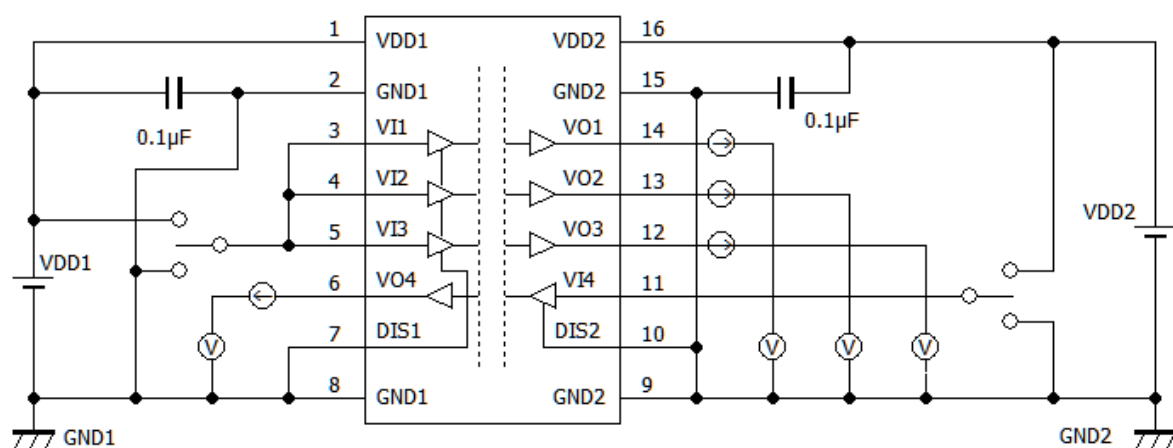


Fig.12-2-3. DCL541A01/DCL541B01 VOH/VOL Test Circuit

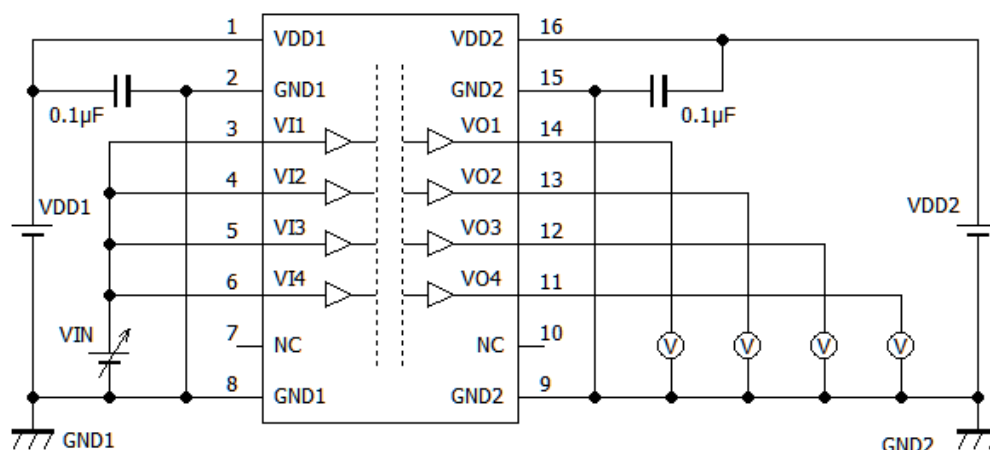


Fig.12-3-1. DCL540C01/DCL540D01 VIH/VIL Test Circuit

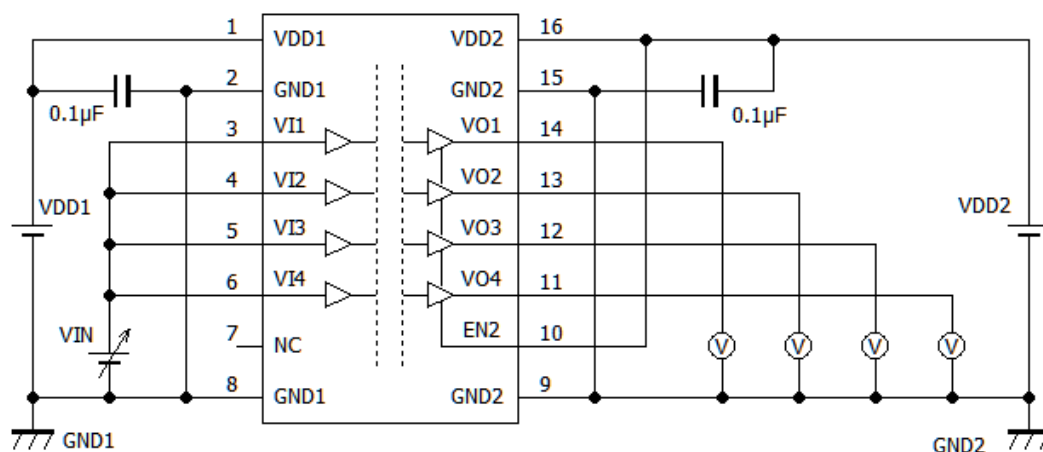


Fig.12-3-2. DCL540L01/DCL540H01 VIH/VIL Test Circuit

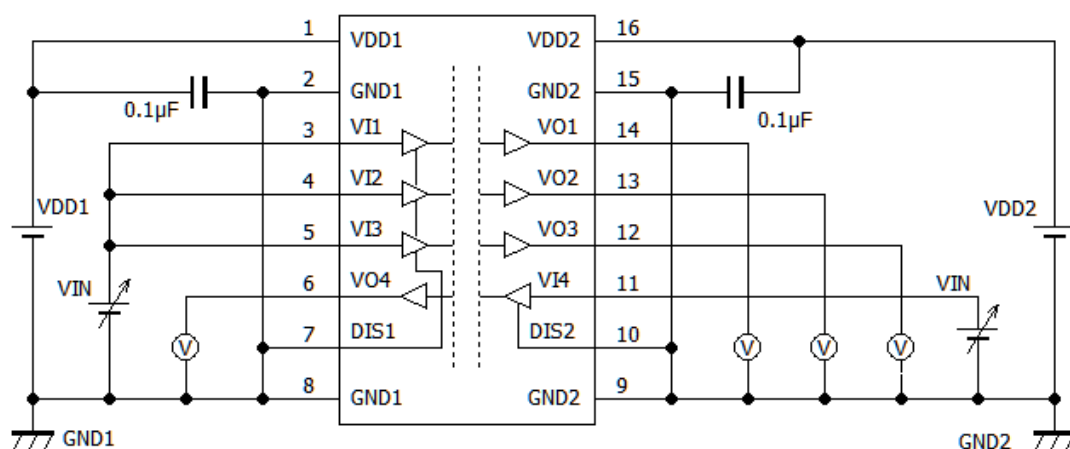
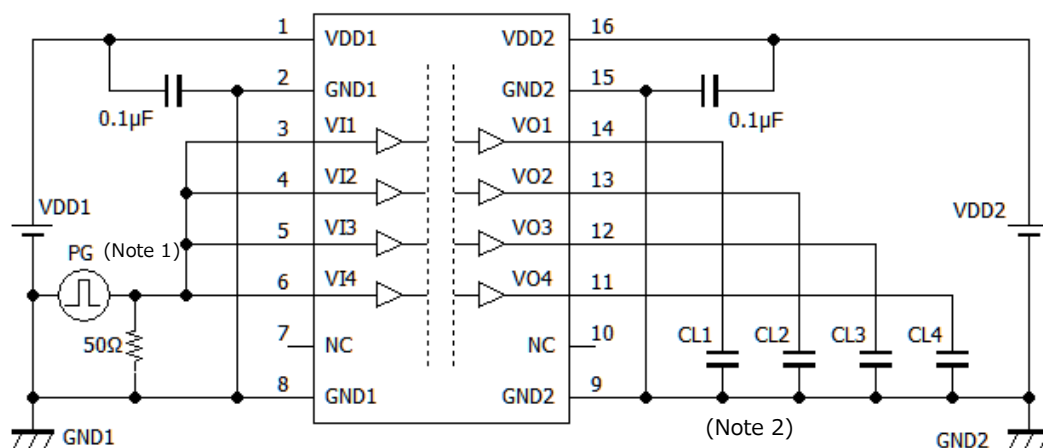


Fig.12-3-3. DCL541A01/DCL541B01 VIH/VIL Test Circuit



(Note 1) The input pulse is supplied by a generator having the following characteristics: PRR $\leq$ 50 kHz, 50 % duty cycle, $t_r \leq 2$ ns, $t_f \leq 2$ ns, $Z_0 = 50 \Omega$. At the input, 50 Ω resistor is required to terminate input generator signal. It is needed not in actual application.

(Note 2) CLx=15 pF includes instrumentation and fixture capacitance.

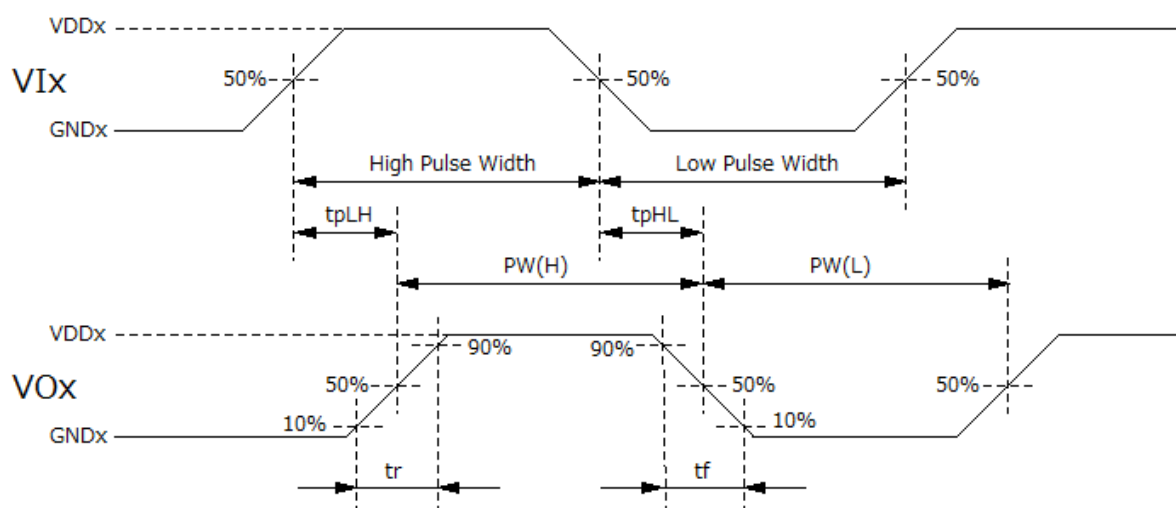
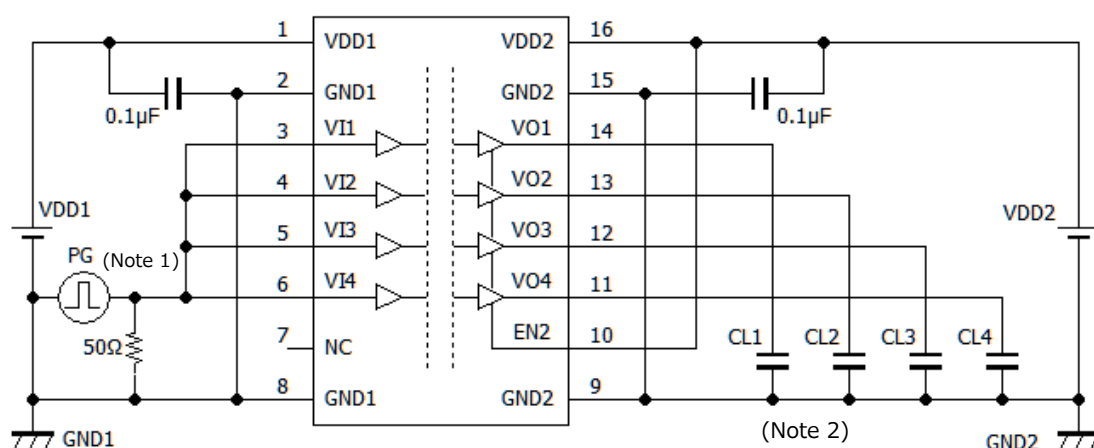


Fig.12-4-1. DCL540C01/DCL540D01 Switching Test Circuit and Voltage Waveforms



(Note 1) The input pulse is supplied by a generator having the following characteristics: $PRR \leq 50$ kHz, 50 % duty cycle, $t_r \leq 2$ ns, $t_f \leq 2$ ns, $Z_o = 50 \Omega$. At the input, 50Ω resistor is required to terminate input generator signal. It is needed not in actual application.

(Note 2) $CL_x = 15$ pF includes instrumentation and fixture capacitance

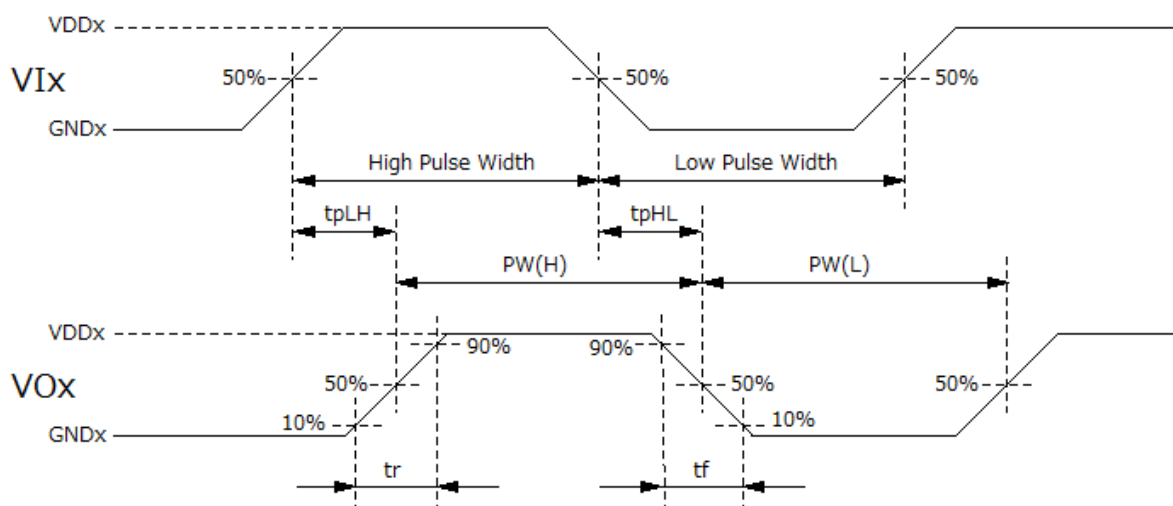
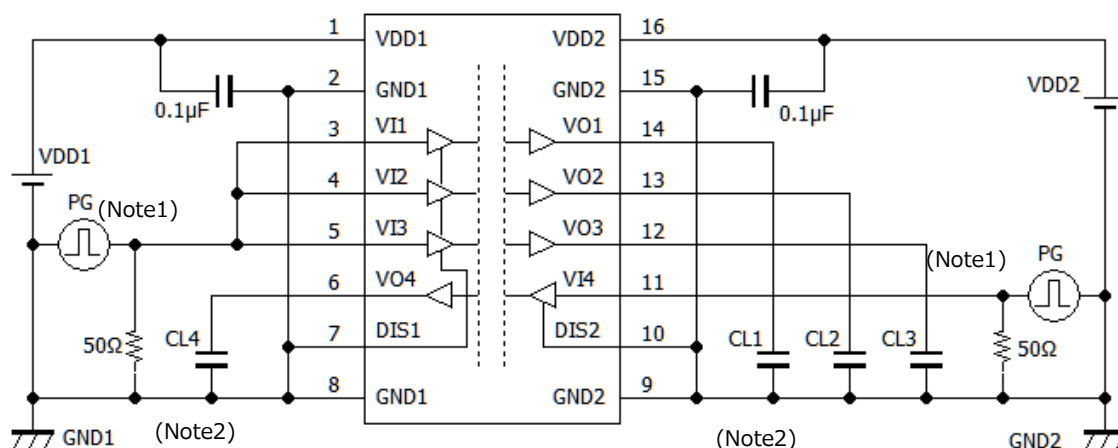


Fig.12-4-2. DCL540L01/DCL540H01 Switching Test Circuit and Voltage Waveforms



(Note 1) The input pulse is supplied by a generator having the following characteristics: $PRR \leq 50$ kHz, 50 % duty cycle, $t_r \leq 2$ ns, $t_f \leq 2$ ns, $Z_o = 50 \Omega$. At the input, 50Ω resistor is required to terminate input generator signal. It is needed not in actual application.

(Note 2) $CLx = 15$ pF includes instrumentation and fixture capacitance

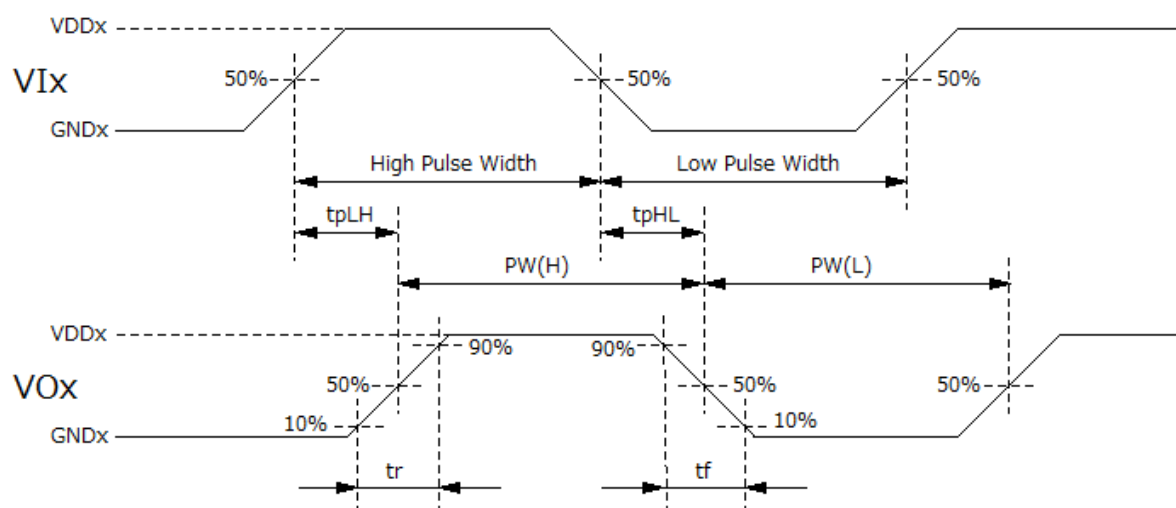


Fig.12-4-3. DCL541A01/DCL541B01 Switching Test Circuit and Voltage Waveforms

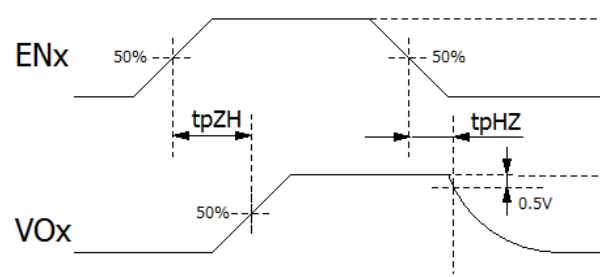
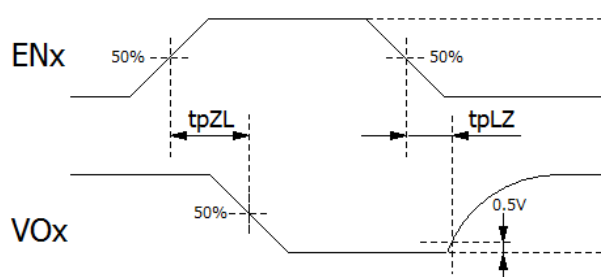
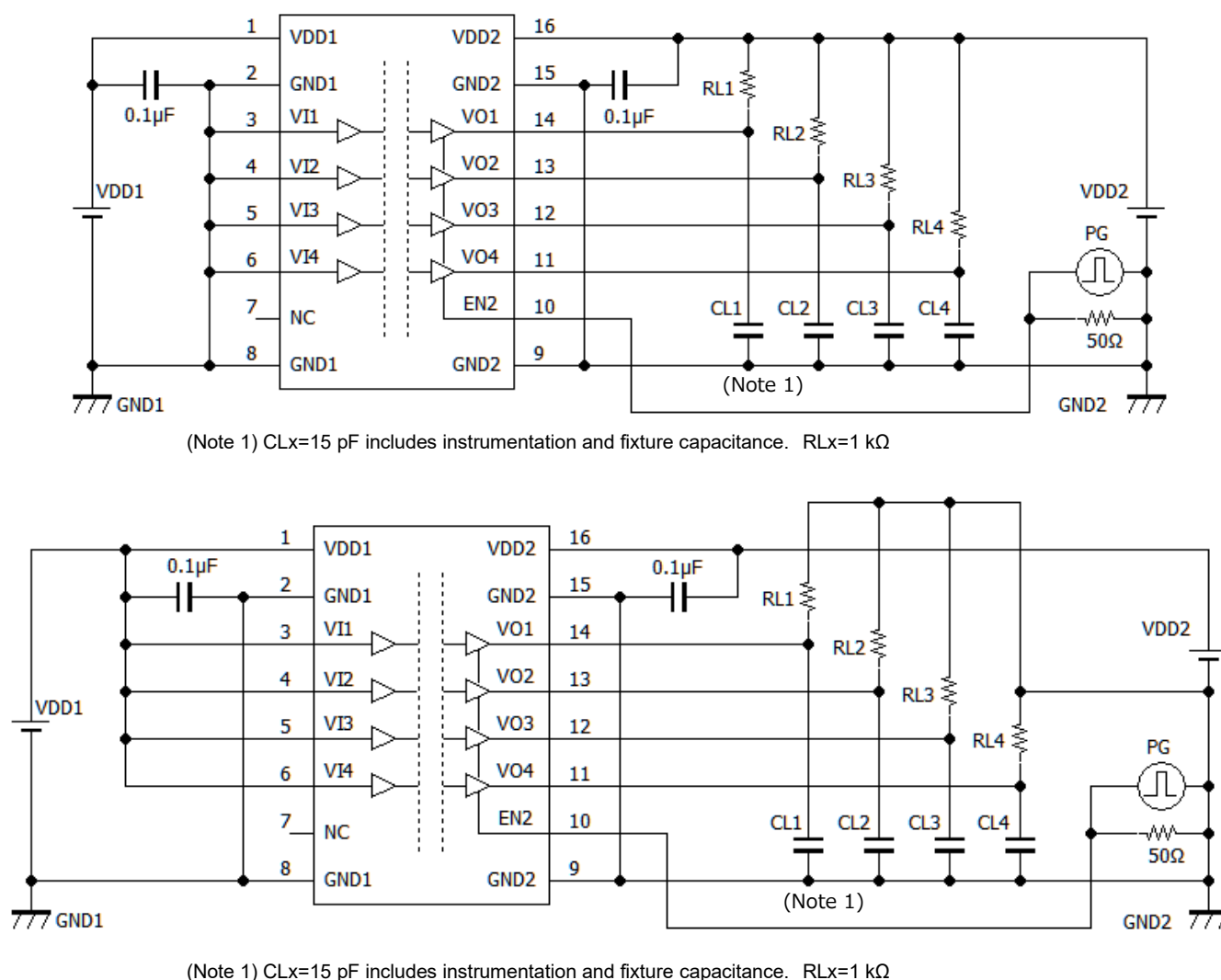
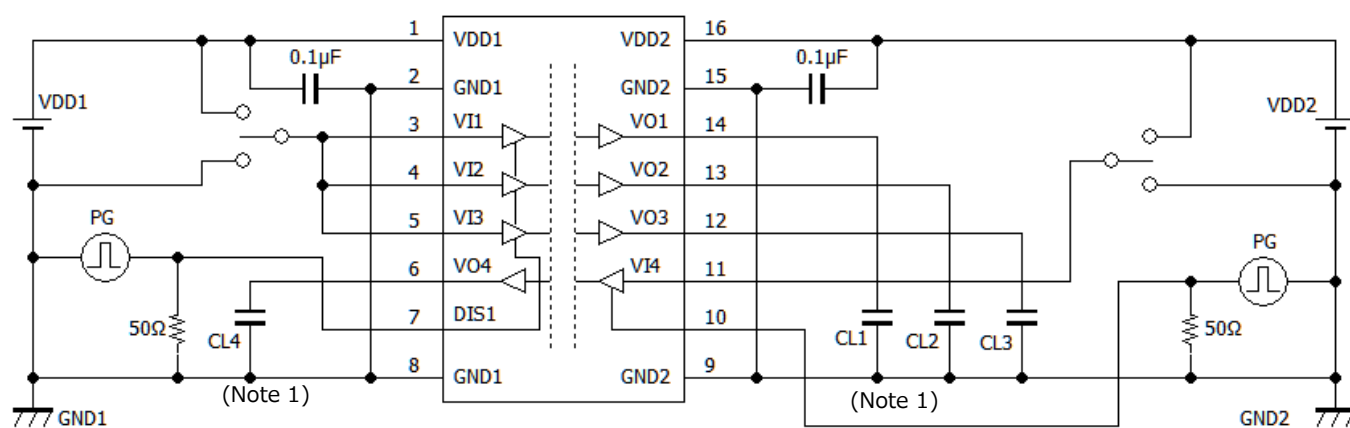


Fig.12-5. DCL540L01/ DCL540H01 Enable Propagation Delay Time Test Circuit and Waveforms



(Note 1) CLx=15 pF includes instrumentation and fixture capacitance.

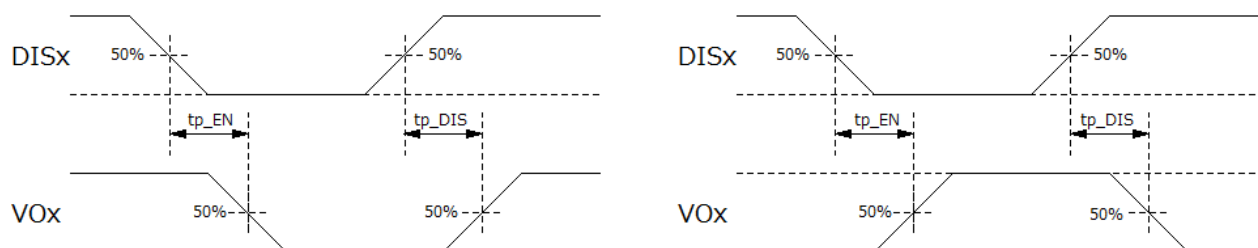
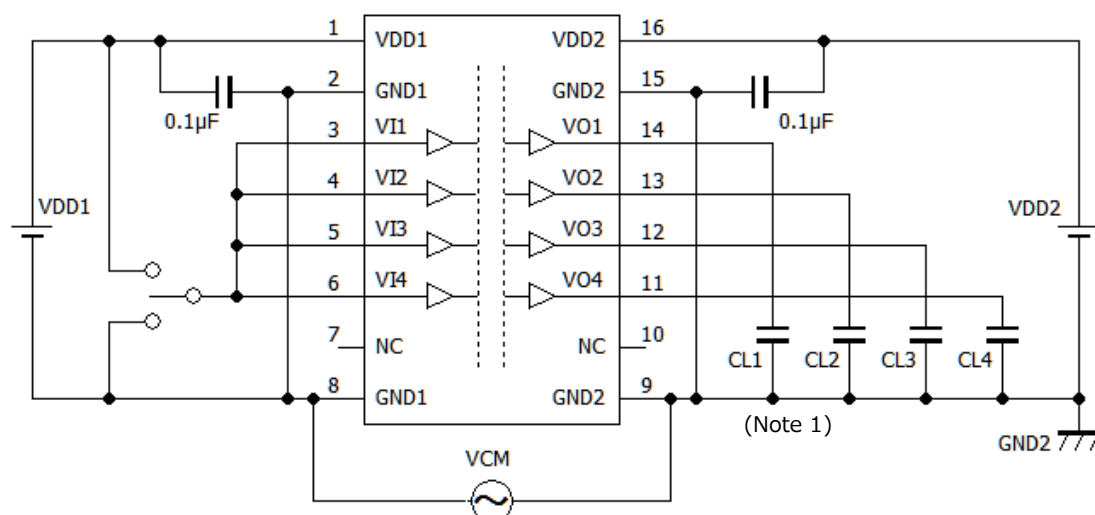
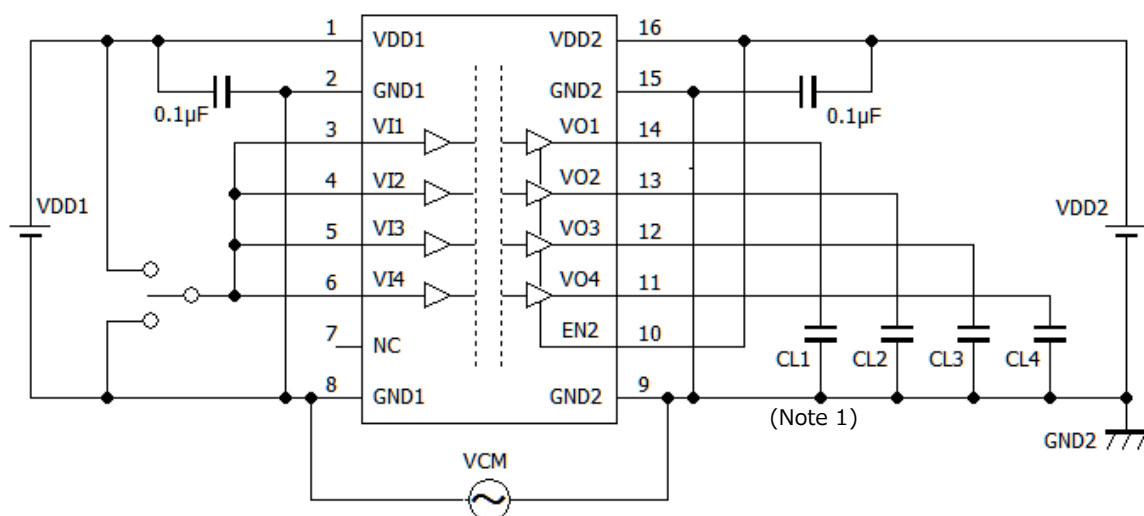


Fig.12-6. DCL541A01/DCL541B01 Disable Propagation Delay Time Test Circuit and Waveforms



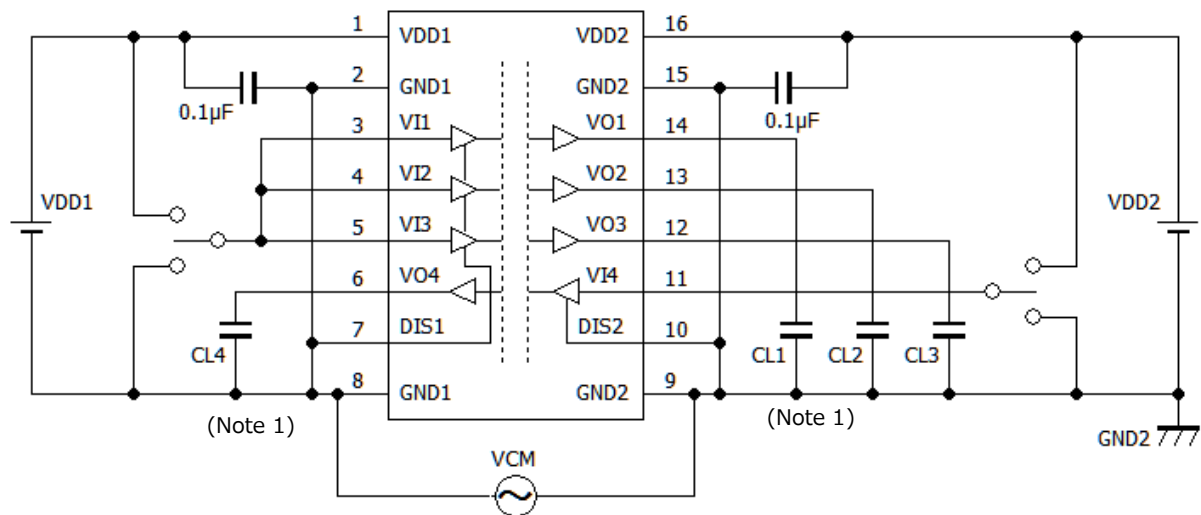
(Note 1) CLx=15 pF includes instrumentation and fixture capacitance.

Fig.12-7-1. DCL540C01/DCL540D01 Common-Mode Transient Immunity Test Circuit



(Note 1) CLx=15 pF includes instrumentation and fixture capacitance.

Fig.12-7-2. DCL540L01/DCL540H01 Common-Mode Transient Immunity Test Circuit



(Note 1) CLx=15 pF includes instrumentation and fixture capacitance.

Fig.12-7-3. DCL541A01/DCL541B01 Common-Mode Transient Immunity Test Circuit

13.Characteristics Curves

Note: The following characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

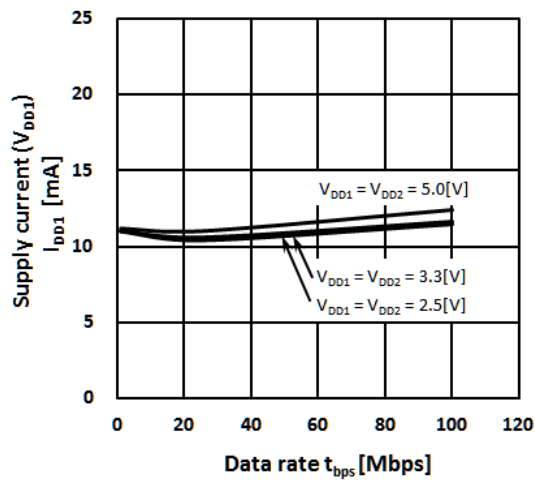


Fig.13-1. DCL540xx01 I_{DD1} Supply Current—Data rate

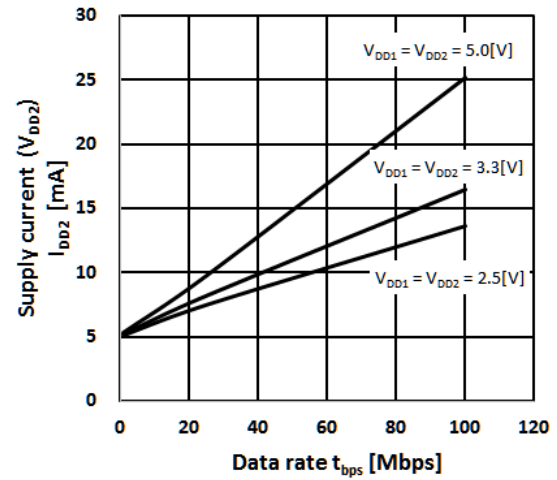


Fig.13-2. DCL540xx01 I_{DD2} Supply Current—Data rate

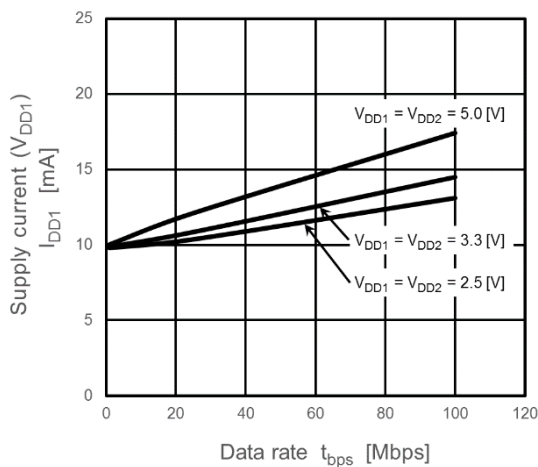


Fig.13-3. DCL541xx01 I_{DD1} Supply Current—Data rate

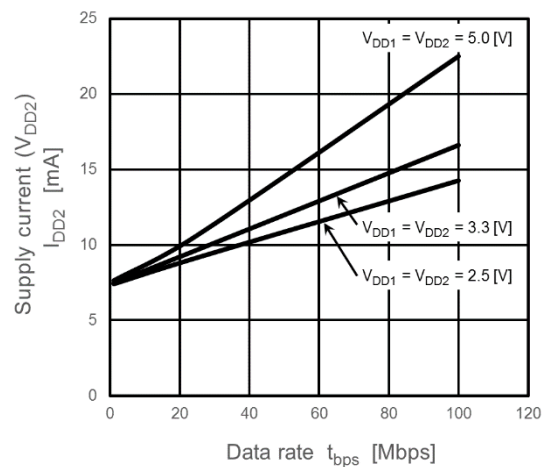


Fig.13-4. DCL541xx01 I_{DD2} Supply Current—Data rate

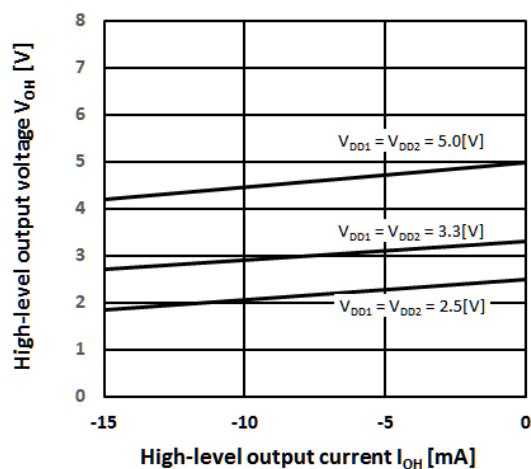


Fig.13-5. V_{OH} - I_{OH}

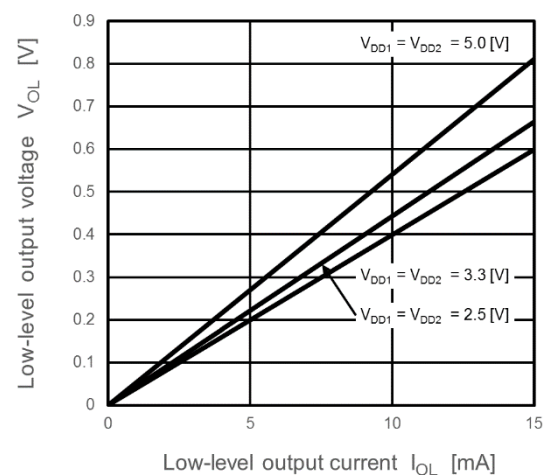


Fig.13-6. V_{OL} - I_{OL}

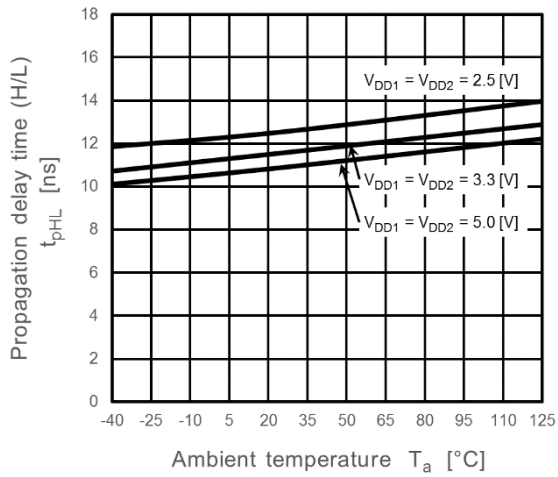


Fig.13-7. Propagation Delay Time t_{pHL} - T_a

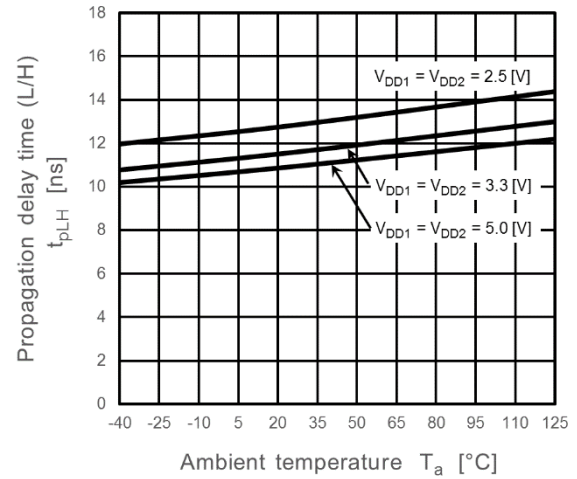


Fig.13-8. Propagation Delay Time t_{pLH} - T_a

14. Application Note

14-1. Eye diagram

The following figure shows typical eye diagrams of DCL541xx01 at the maximum data rate of 150Mbps with pseudorandom bit sequences (PRBS), supply voltage 3.0 V for reference only.

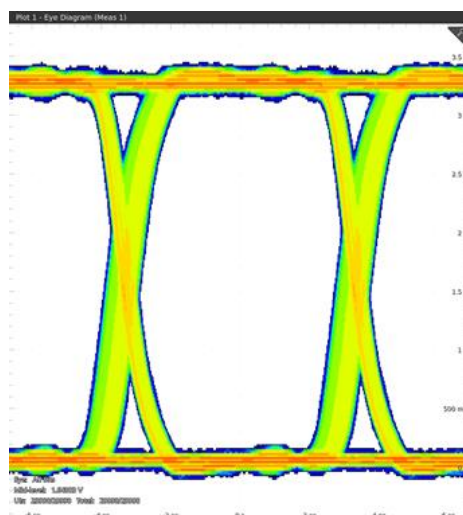


Fig.14-1 DCL541A01 Eye diagram at 150Mbps

14-2. PCB layout

A ceramic capacitor (0.1 μ F) should be connected between pin 1 (V_{DD1}) and pin 2 (GND_1) for V_{DD1} and between pin 16 (V_{DD2}) and pin 15 (GND_2) for V_{DD2} , and it should be the layout on the IC as close as possible (less than 10mm). Otherwise, the IC may not operate properly.

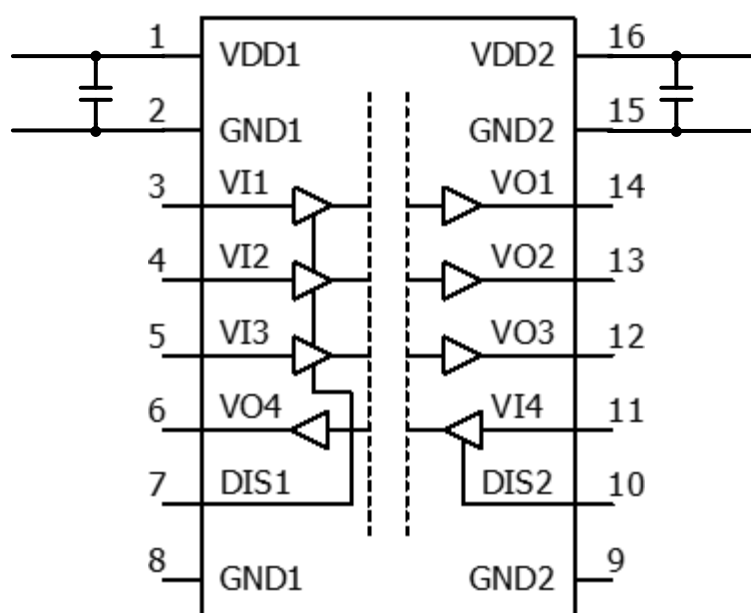
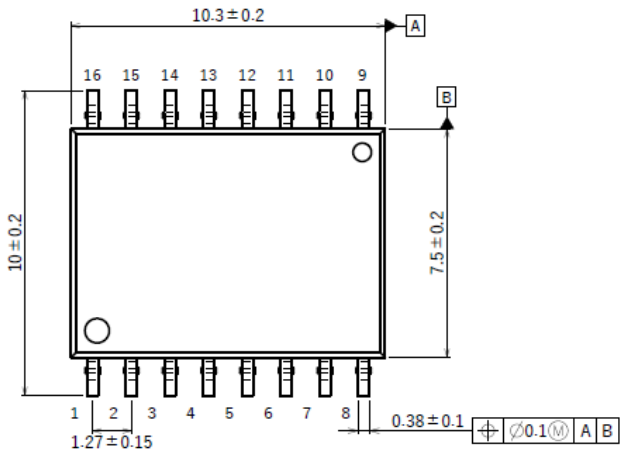
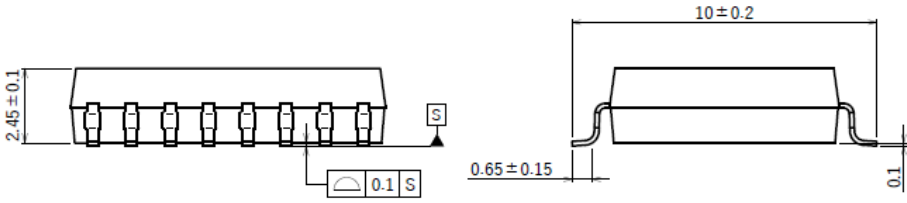


Fig.14-2 Recommended Printed Circuit Board Layout

15. Package Information

Implementation category	Surface Mount
Pin Number	16
Weight (g)	0.426 (Typical)
Package Dimension Width × Length × Height (mm)	10.3 × 10.0 × 2.45 (Typical)
Package Dimension(mm) / Land Pattern Example (mm)	Package Dimension  Land Pattern Dimensions (for reference only) 

RESTRICTIONS ON PRODUCT USE

Toshiba Corporation and its subsidiaries and affiliates are collectively referred to as "TOSHIBA". Hardware, software and systems described in this document are collectively referred to as "Product".

- TOSHIBA reserves the right to make changes to the information in this document and related Product without notice.
- This document and any information herein may not be reproduced without prior written permission from TOSHIBA. Even with TOSHIBA's written permission, reproduction is permissible only if reproduction is without alteration/omission.
- Though TOSHIBA works continually to improve Product's quality and reliability, Product can malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Before customers use the Product, create designs including the Product, or incorporate the Product into their own applications, customers must also refer to and comply with (a) the latest versions of all relevant TOSHIBA information, including without limitation, this document, the specifications, the data sheets and application notes for Product and the precautions and conditions set forth in the "TOSHIBA Semiconductor Reliability Handbook" and (b) the instructions for the application with which the Product will be used with or for. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this Product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. **TOSHIBA ASSUMES NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.**
- **PRODUCT IS NEITHER INTENDED NOR WARRANTED FOR USE IN EQUIPMENTS OR SYSTEMS THAT REQUIRE EXTRAORDINARILY HIGH LEVELS OF QUALITY AND/OR RELIABILITY, AND/OR A MALFUNCTION OR FAILURE OF WHICH MAY CAUSE LOSS OF HUMAN LIFE, BODILY INJURY, SERIOUS PROPERTY DAMAGE AND/OR SERIOUS PUBLIC IMPACT ("UNINTENDED USE").** Except for specific applications as expressly stated in this document, Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, lifesaving and/or life supporting medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, and devices related to power plant. **IF YOU USE PRODUCT FOR UNINTENDED USE, TOSHIBA ASSUMES NO LIABILITY FOR PRODUCT.** For details, please contact your TOSHIBA sales representative or contact us via our website.
- Do not disassemble, analyze, reverse-engineer, alter, modify, translate or copy Product, whether in whole or in part.
- Product shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.
- The information contained herein is presented only as guidance for Product use. No responsibility is assumed by TOSHIBA for any infringement of patents or any other intellectual property rights of third parties that may result from the use of Product. No license to any intellectual property right is granted by this document, whether express or implied, by estoppel or otherwise.
- **ABSENT A WRITTEN SIGNED AGREEMENT, EXCEPT AS PROVIDED IN THE RELEVANT TERMS AND CONDITIONS OF SALE FOR PRODUCT, AND TO THE MAXIMUM EXTENT ALLOWABLE BY LAW, TOSHIBA (1) ASSUMES NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (2) DISCLAIMS ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO SALE, USE OF PRODUCT, OR INFORMATION, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.**
- Do not use or otherwise make available Product or related software or technology for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). Product and related software and technology may be controlled under the applicable export laws and regulations including, without limitation, the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of Product or related software or technology are strictly prohibited except in compliance with all applicable export laws and regulations.
- Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. **TOSHIBA ASSUMES NO LIABILITY FOR DAMAGES OR LOSSES OCCURRING AS A RESULT OF NONCOMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS.**