

Features

- 👉 150 Mbps Data Rate
- 👉 5 kV_{RMS} Isolation Rating (WSOP)
- 👉 ±200 kV/μs typ static CMTI, ±150 kV/μs typ dynamic CMTI
- 👉 Low Power Consumption, typ 3 mA/ch @1 Mbps
- 👉 Low Propagation Delay: 12 ns Typical
- 👉 Default Output Low (AL994xF) and High (AL994x)
- 👉 Wide Temperature Range: -40°C to +125°C
- 👉 SOP-16, QSOP-16 and WSOP-16 package
- 👉 Robust electromagnetic compatibility (EMC)
 - Low emissions
 - System level ESD, EFT and surge immunity
- 👉 Safety-Related Certifications:
 - VDE Certification according to DIN VDE V 0884-17(IEC60747-17)
 - 5000V_{RMS} (WSOP16, WSOP8), 3750V_{RMS} (SOP8) Isolation Rating per UL 1577
 - CQC Certification per GB 4943.1
 - CAS, TUV and CB certifications
- 👉 Qualified for Automotive Applications with AEC-Q100 Reliability Test (with suffix -S)

Applications

- 👉 Industrial Automation
- 👉 Motor Control
- 👉 Power Supplies
- 👉 Isolated interface and general-purpose isolation

Description

The AL994x devices are high-performance, 4-channel digital isolators with 5000 V_{RMS} (WSOP-16 packages), 3750 V_{RMS} (SOP-16, QSOP-16 package), isolation ratings per UL 1577. These devices are also to be certified by VDE, UL, CSA, CQC and CB.

The AL994x devices provide high reliability and high performance at low power consumption while isolating digital input and output. Each isolation signal channel is separated by a double capacitive silicon dioxide insulation barrier. The AL9940 device has four channels in the same direction while the AL9941 device has three channels in the forward direction and one channel in opposite direction. The AL9942 device has two channels in the forward direction and two channels in opposite direction. In the event of input power or signal loss, the default output is low for devices with suffix F and high for devices without suffix F.

The common mode transient immunity (CMTI) and electromagnetic compatibility of the AL994x devices have been significantly enhanced through innovative circuit design and optimized structure.

AL994x family is available in SOP-16, QSOP-16, WSOP-16 package, and is characterized from -40°C to +125°C.

Function Block Diagram

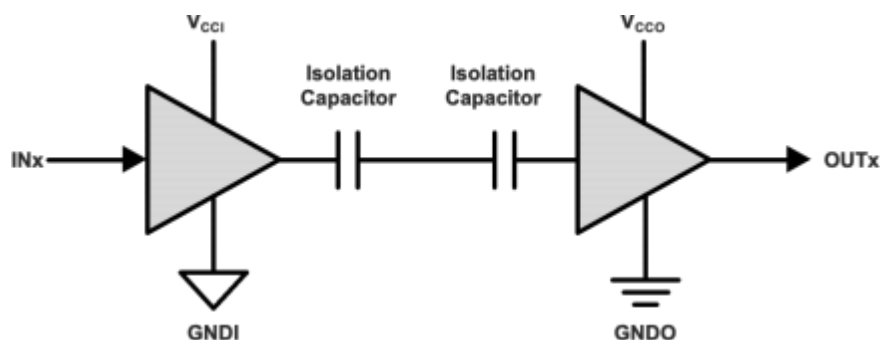
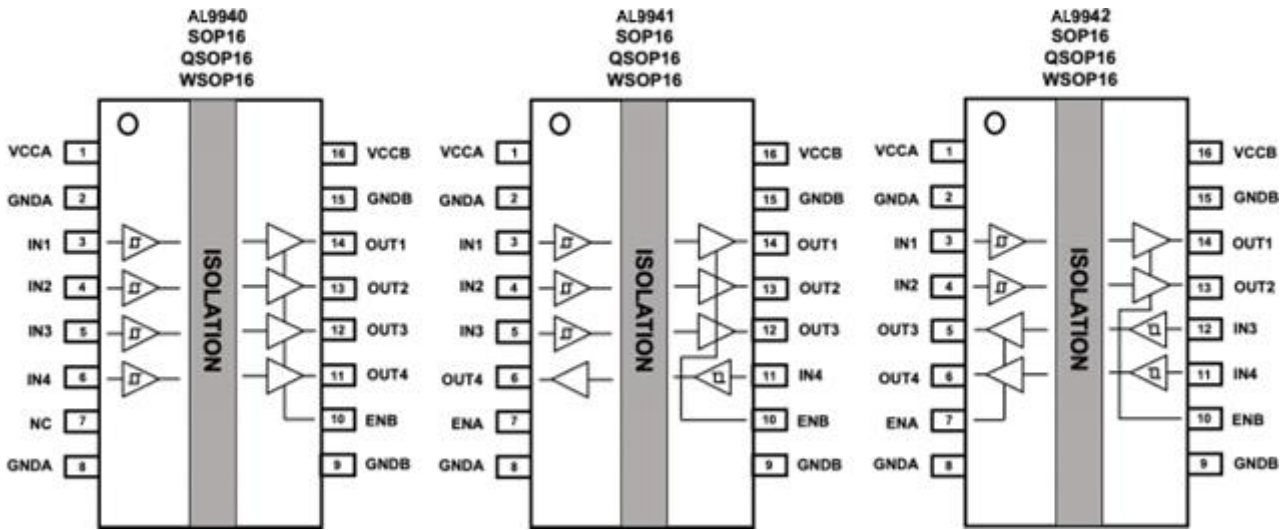


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Pin Configuration and Functions



Pin Functions

Name	Pin			I/O	Description
	AL9940	AL9941	AL9942		
VCCA	1	1	1	-	Power supply, VCCA
GND A	2	2	2	-	Ground connection for VCCA
IN1	3	3	3	I	Input, channel 1
IN2	4	4	4	I	Input, channel 2
IN3	5	5	12	I	Input, channel 3
IN4	6	11	11	I	Input, channel 4
NC	7	-	-		
ENA	-	7	7	I	Side A enable pin
GND A	8	8	8	-	Ground connection for VCCA
GND B	9	9	9	-	Ground connection for VCCB
ENB	10	10	10	I	Side B enable pin
OUT4	11	6	6	O	Output, channel 4
OUT3	12	12	5	O	Output, channel 3
OUT2	13	13	13	O	Output, channel 2
OUT1	14	14	14	O	Output, channel 1
GND B	15	15	15	-	Ground connection for VCCB
VCCB	16	16	16	-	Power supply, VCCB

(1) ENA: Side A OUTx enable when ENA = high or open, and in high-impedance state when ENA is low.

(2) ENB: Side B OUTx enable when ENB = high or open, and in high-impedance state when ENB is low.

Specifications

Absolute Maximum Ratings

Parameter		Min	Max	Unit
V_{CC}	Supply voltage, V_{CCA} , V_{CCB}	-0.5	6	V
V_{IO}	Voltage at IN1, IN2, IN3, IN4, OUT1, OUT2, OUT3, OUT4, ENA, ENB	-0.5	$V_{CC} + 0.5$	V
I_O	Output current	-15	15	mA
T_J	Operating virtual junction temperature		150	°C
T_{stg}	Storage temperature	-65	150	°C

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

(2) This data was taken with the JEDEC low effective thermal conductivity test board.

(3) This data was taken with the JEDEC standard multilayer test boards.

ESD, Electrostatic Discharge Protection

Parameter	Condition	Value	Unit
HBM, per ANSI/ESDA/JEDEC JS-001/ANSI/ESD STM5.5.1 ⁽¹⁾	All Pin	±6	kV
CDM, per ANSI/ESDA/JEDEC JS-002 ⁽²⁾	All Pin	±1.5	kV
Latch up, per JESD78	All Pin	600	mA

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions

Parameter		Min	Typ	Max	Unit
V_{CCX}	Supply voltage, V_{CCA} , V_{CCB} ⁽¹⁾	2.25		5.5	V
$V_{CC(UVLO+)}$	UVLO threshold when supply voltage is rising ⁽²⁾		2	2.25	V
$V_{CC(UVLO-)}$	UVLO threshold when supply voltage is falling ⁽²⁾	1.7	1.85		V
$V_{HYS(UVLO)}$	Supply voltage UVLO hysteresis	60	150		mV
I_{OH}	High-Level output current	$V_{CCB} = 5\text{ V}$			mA
		$V_{CCB} = 3.3\text{ V}$			mA
		$V_{CCB} = 2.5\text{ V}$			mA
I_{OL}	High-Level output current	$V_{CCB} = 5\text{ V}$		4	mA
		$V_{CCB} = 3.3\text{ V}$		2	mA
		$V_{CCB} = 2.5\text{ V}$		1	mA
V_{IH}	High-level input voltage (data input)	2		V_{CC}	V
V_{IL}	Low-level input voltage (data input)	0		0.8	V
f_{data}	Data rate ⁽³⁾	0		150	Mbps
T_A	Operating ambient temperature	-40	25	125	°C

(1) V_{CCA} is input side V_{CC} ; V_{CCB} is output side V_{CC} ;

(2) $V_{CC(UVLO+)}$, $V_{CC(UVLO-)}$, $V_{HYS(UVLO)}$ are same to V_{CCA} and V_{CCB} ;

(3) 150 Mbps is the data rate tested in lab, although higher data rates are possible.

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
16-Pin SOP	79	31	°C/W
16-Pin QSOP	112	58	°C/W
16-Pin WSOP	93	52	°C/W

Insulation Specifications

Symbol	Parameter	Conditions	Value			Unit
			SOP16	QSOP16	WSOP16	
CLR	External clearance	Shortest terminal-to-terminal distance through air	> 4.0	> 4.0	> 8.0	mm
CPG	External creepage	Shortest terminal-to-terminal distance across the package surface	> 4.0	> 4.0	> 8.0	mm
DTI	Distance through the insulation	Minimum internal gap (internal clearance)	> 22	> 22	> 22	μm
DTC	Distance through the Molding compound	Minimum internal distance across the conductors inside the package	0.45	0.45	0.8	mm
CTI	Comparative tracking index	DIN EN 60112 (VDE 0303-11); IEC 60112; UL 746A	> 600	> 600	> 600	V
	Material group	According to IEC 60664-1	I	I	I	
	Over-voltage category	For Rated Mains Voltage ≤ 150 V _{RMS}	I-IV	I-IV	I-IV	
		For Rated Mains Voltage ≤ 300 V _{RMS}	I-III	I-III	I-IV	
		For Rated Mains Voltage ≤ 600 V _{RMS}	I-II	I-II	I-IV	
		For Rated Mains Voltage ≤ 1000 V _{RMS}	I	I	I-III	
	Climatic category		40/125/21	40/125/21	40/125/21	
	Pollution degree		2	2	2	
DIN V VDE V 0884-17 ⁽¹⁾⁽²⁾						
V _{IORM}	Maximum repetitive isolation voltage	AC voltage	637	637	1414	V _{PK}
V _{IOWM}	Maximum working isolation voltage	AC voltage; TDDb Test	450	450	1000	V _{RMS}
		DC voltage	637	637	1414	V _{DC}
V _{IOTM}	Maximum transient isolation voltage	V _{TEST} = V _{IOTM} , t = 60 s (qualification); V _{TEST} = 1.2 × V _{IOTM} , t = 1 s (100% production)	5300	5300	7000	V _{PK}
V _{IOSM}	Maximum surge isolation voltage ⁽³⁾	Test method per IEC 62368-1, 1.2/50 μs waveform, V _{TEST} = 1.3 × V _{IOSM} (qualification)	5980	5980	6500	V _{PK}

Q _{pd}	Apparent charge	Method a, After Input/Output safety test subgroup 2/3, V _{ini} = V _{IOTM} , t _{ini} = 60 s; V _{pd(m)} = 1.2 × V _{IORM} , t _m = 10 s	≤ 5	≤ 5	≤ 5	pC
		Method a, After environmental tests subgroup 1, V _{ini} = V _{IOTM} , t _{ini} = 60 s; V _{pd(m)} = 1.6 × V _{IORM} , t _m = 10 s	≤ 5	≤ 5	≤ 5	
		Method b1; At routine test (100% production) and preconditioning (type test), V _{ini} = 1.2 × V _{IOTM} , t _{ini} = 1 s; V _{pd(m)} = 1.875 × V _{IORM} , t _m = 1 s	≤ 5	≤ 5	≤ 5	
C _{io}	Isolation capacitance	V _{io} = 0.4 × sin (2πft), f = 1 MHz	~0.5	~0.5	~0.5	pF
R _{io}	Isolation resistance	V _{io} = 500 V, TA= 25°C	> 10 ¹²	> 10 ¹²	> 10 ¹²	Ω
		V _{io} = 500 V, 100. C ≤ TA ≤ 125. C	> 10 ¹¹	> 10 ¹¹	> 10 ¹¹	Ω
		V _{io} = 500 V at T S= 150°C	> 10 ⁹	> 10 ⁹	> 10 ⁹	Ω
UL 1577						
V _{iso}	Withstanding isolation voltage	V _{TEST} = V _{ISO} , t = 60 s(qualification); V _{TEST} = 1.2 × V _{ISO} , t = 1 s (100% production)	3750	3750	5000	V _{RMS}

(1) All pins on each side of the barrier tied together creating a two-terminal device.

(2) This coupler is suitable for safe electrical insulation only within the safety operating ratings. Compliance with the safety ratings shall be ensured by means of suitable protective circuits.

(3) Testing must be carried out in oil.

Safety-Related Certifications

VDE	UL	TUV	CQC	CSA	CB
Certified according to DIN VDE V 0884-17	Certified according to UL 1577 and CSA Component Acceptance Notice 5A	Certified according to EN IEC 62368-1 and EN IEC 61010-1	Certified according to GB 4943.1	Certified CSA C22.2 No. 62368-1 and CAN/CSA-C22.2 No. 60601-1	Certified according to EN IEC 62368-1
Basic insulation (WSOP) VIORM= 1414 VIOSM= 6500 (SOP, QSOP) VIORM= 637 VIOSM= 5500	(WSOP)Single protection, 5000Vrms (SOP, QSOP)Single protection, 3750Vrms	5000Vrms reinforced insulation (WSOP), 800 Vrms maximum work voltage. 3750Vrms basic insulation (SOP, QSOP), 400V rms maximum work voltage.	Reinforced insulation (WSOP), Altitude<=5000m,80 0V rms maximum work voltage. Basic insulation (SOP, QSOP), Altitude<=5000m,40 0V rms maximum work voltage.	400Vrms basic insulation (SOP, QSOP) and 600V rms reinforced insulation (WSOP) working voltage per CSA C22.2 No. 62368-1:19 3rd, IEC 62368-1:2018 Ed. 3(in pollution degree 2, material group I) 2 MOPP (Means of Patient Protection) insulation requirements for 250Vrms (WSOP) in CAN/CSA-C22.2 No. 60601-1:14, IEC 60601-1:2005 + AMD1:2012	Reinforced insulation (WSOP), Altitude<=5000m,80 0V rms maximum work voltage. Basic insulation (SOP, QSOP), Altitude<=5000m,40 0V rms maximum work voltage.

Certificate No.40054570	Report Reference E524241	Registration No. AK 50524505 0001 AK 50524506 0001 AK 50550847 0001 AK 50550849 0001	Certificate No. CQC21001303701 CQC22001332218 CQC22001332219	Master contract: 302375	Ref. Certif. No. CN54369 CN56354 CN56355
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Safety Limiting Values

Parameter	Conditions ⁽¹⁾	Min	Typ	Max	Unit
Safety supply current	$R_{\theta JA} = 79^{\circ}\text{C/W}$, $V_I = 5\text{ V}$, $T_J = 150^{\circ}\text{C}$, $T_A = 25^{\circ}\text{C}$ (SOP16)			316.4	mA
	$R_{\theta JA} = 112^{\circ}\text{C/W}$, $V_I = 5\text{ V}$, $T_J = 150^{\circ}\text{C}$, $T_A = 25^{\circ}\text{C}$ (QSOP16)			223.2	
	$R_{\theta JA} = 93^{\circ}\text{C/W}$, $V_I = 5\text{ V}$, $T_J = 150^{\circ}\text{C}$, $T_A = 25^{\circ}\text{C}$ (WSOP16)			268.8	
Safety total power	$R_{\theta JA} = 79^{\circ}\text{C/W}$, $T_J = 150^{\circ}\text{C}$, $T_A = 25^{\circ}\text{C}$ (SOP16)			1582.2	mW
	$R_{\theta JA} = 112^{\circ}\text{C/W}$, $T_J = 150^{\circ}\text{C}$, $T_A = 25^{\circ}\text{C}$ (QSOP16)			1116.0	
	$R_{\theta JA} = 93^{\circ}\text{C/W}$, $T_J = 150^{\circ}\text{C}$, $T_A = 25^{\circ}\text{C}$ (WSOP16)			1344	
Maximum safety temperature				150	$^{\circ}\text{C}$

(1) The assumed junction-to-air thermal resistance in the Thermal Information is that of a device installed on a high-K test board for leaded surface-mount packages.

Electrical Characteristics

$V_{CCA} = V_{CCB} = 2.25\text{ V} \sim 5.5\text{ V}$, $T_A = -40^{\circ}\text{C} \sim +125^{\circ}\text{C}$, Typical value is in $V_{CC} = 3.3\text{ V}$, $T_A = +25^{\circ}\text{C}$.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Input Electrical Specifications						
V_{IH}	Logic Input High Voltage	Input signal, IN1, IN2, IN3, IN4	2.0			V
V_{IL}	Logic Input Low Voltage	Input signal, IN1, IN2, IN3, IN4			0.8	V
V_{IT+}	Rising input threshold voltage	Input signal, IN1, IN2, IN3, IN4		1.6	2	V
V_{IT-}	Falling input threshold voltage	Input signal, IN1, IN2, IN3, IN4	0.8	1.2		V
V_{HYS}	Input threshold voltage hysteresis			0.4		V
V_{IH_EN}	Enable Input High Voltage	Enable signal	2.0			V
V_{IL_EN}	Enable Input Low Voltage	Enable signal			0.8	V
V_{IT+_EN}	Enable Rising input threshold voltage	Enable signal		1.4	2	V
V_{IT-_EN}	Enable Falling input threshold voltage	Enable signal	0.8	1.2		V
V_{HYS_EN}	Enable Input threshold voltage hysteresis	Enable signal		0.2		V

I_{IH}	High-level input current	$V_{IH} = V_{CCA}$ at IN1, IN2, IN3, IN4 ⁽¹⁾		2.5	10	μA
I_{IL}	Low-level input current	$V_{IL} = 0 V$ at IN1, IN2, IN3, IN4 ⁽¹⁾	-10	-2.5		μA
I_{OH}	High-level output current	$V_{CCB} = 5 V \pm 10\%$	-4			mA
		$V_{CCB} = 3.3 V \pm 10\%$	-2			
		$V_{CCB} = 2.5 V \pm 10\%$	-1			
I_{OL}	Low-level output current	$V_{CCB} = 5 V \pm 10\%$			4	mA
		$V_{CCB} = 3.3 V \pm 10\%$			2	
		$V_{CCB} = 2.5 V \pm 10\%$			1	
V_{OH}	High-level output voltage	$V_{CCB} = 5 V \pm 10\%$, $I_{OH} = -4 mA$; Test OUT1, OUT2	$V_{CCB} - 0.4$	$V_{CCB} - 0.2$		mV
		$V_{CCB} = 3.3 V \pm 10\%$, $I_{OH} = -2 mA$; Test OUT1, OUT2	$V_{CCB} - 0.3$	$V_{CCB} - 0.15$		
		$V_{CCB} = 2.5 V \pm 10\%$, $I_{OH} = -1 mA$; Test OUT1, OUT2	$V_{CCB} - 0.2$	$V_{CCB} - 0.1$		
V_{OL}	Low-level output voltage	$V_{CCB} = 5 V \pm 10\%$, $I_{OL} = 4 mA$; Test OUT1, OUT2		0.2	0.4	V
		$V_{CCB} = 3.3 V \pm 10\%$, $I_{OL} = 2 mA$; Test OUT1, OUT2		0.15	0.3	
		$V_{CCB} = 2.5 V \pm 10\%$, $I_{OL} = 1 mA$; Test OUT1, OUT2		0.1	0.2	
CMTI	Common-mode transient immunity	Static CMTI	150	200		kV/ μs
		Dynamic CMTI	100	150		kV/ μs
C_i	Input capacitance ⁽¹⁾			2		pF

(1) Provided by bench test and design simulation

Timing Specifications-5 V Supply

$V_{CCA} = V_{CCB} = 5\text{ V} \pm 10\%$, $T_A = -40^\circ\text{C} \sim +125^\circ\text{C}$. Typical value is in $V_{CC} = 5\text{ V}$, $T_A = +25^\circ\text{C}$, $C_L = 15\text{ pF}$ to GND.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{data}	Translation data rate				150	Mpbs
t_{PLH}	Propagation delay time			11.5	22	ns
t_{PHL}	Propagation delay time			12	22	ns
PWD	Pulse width distortion ⁽¹⁾ $ t_{\text{PHL}} - t_{\text{PLH}} $			0.5	5	ns
$t_{\text{sk(CC)}}$	Channel-to-channel output skew time ⁽²⁾	Same direction channels			2.5	ns
$t_{\text{sk(PP)}}$	Channel-to-channel output skew time ⁽²⁾	Same direction channels			4.5	ns
t_r	Output signal rise time ⁽¹⁾			0.7	4	ns
t_f	Output signal fall time ⁽¹⁾			0.7	4	ns
t_{PHZ}	Disable propagation delay, high-to-high impedance output	$C_L = 15\text{ pF}$, $R_L = 1\text{ K}$		20	40	ns
t_{PLZ}	Disable propagation delay, low-to-high impedance output	$C_L = 15\text{ pF}$, $R_L = 1\text{ K}$		18	40	ns
t_{PZH}	Enable propagation delay, high impedance-to-high output	$C_L = 15\text{ pF}$, $R_L = 1\text{ K}$		10.4	40	ns
t_{PZL}	Enable propagation delay, high impedance-to-low output	$C_L = 15\text{ pF}$, $R_L = 1\text{ K}$		8.6	40	ns
Jitter	Eye jitter p-p ⁽¹⁾	$f_{\text{data}} = 100\text{ Mbps}$		800		ps
t_{DO}	Default output delay time from input power loss	Measured from the time V_{CC} goes below 1.7 V.		30	80	ns
t_{su}	Setup time			28	80	us
t_{ie}	Time interval error ⁽¹⁾	$2^{16} - 1$ PRBS data at 100 Mbps ⁽¹⁾		2.4		ns

(1) Provided by bench test and design simulation.

(2) $t_{\text{sk(CC)}}$ & $t_{\text{sk(PP)}}$ is the skew of delay time between different channel of a single device or different devices switching in the same direction while operating at identical supply voltages, temperature, input signals and loads.

Supply Current Characteristics-5 V Supply

$V_{CCA} = V_{CCB} = 5 V \pm 10\%$, $T_A = -40^{\circ}C \sim +125^{\circ}C$. Typical value is in $V_{CC} = 5 V$, $T_A = +25^{\circ}C$, $C_L = 15 pF$ to GND.

Parameter	Description	Supply current	Min	Typ	Max	Unit	
AL9940							
Supply current - DC signal	$V_I = 0 V$ (AL994xF)	I_{CCA}		1.8	2.8	mA	
	$V_I = V_{CCi}$ (AL994x)	I_{CCB}		3.5	7		
	$V_I = V_{CCi}$ (AL994xF)	I_{CCA}		9.5	24		
	$V_I = 0 V$ (AL994x)	I_{CCB}		3.9	6.5		
Supply current - AC signal	All channels switching with square wave clock input; $C_L = 15 pF$	1 Mbps	I_{CCA}		7.8		13.1
			I_{CCB}		4.6		6.6
		10 Mbps	I_{CCA}		8.0		11
			I_{CCB}		6.6		10
		100 Mbps	$I_{CCA}^{(1)}$		10.6	14.7	
			$I_{CCB}^{(1)}$		24.1	33.4	
AL9941							
Supply current - DC signal	$V_I = 0 V$ (AL994xF)	I_{CCA}		2.4	3.9	mA	
	$V_I = V_{CCi}$ (AL994x)	I_{CCB}		4.3	6.3		
	$V_I = V_{CCi}$ (AL994xF)	I_{CCA}		12.0	15.0		
	$V_I = 0 V$ (AL994x)	I_{CCB}		7.0	9.0		
Supply current - AC signal	All channels switching with square wave clock input; $C_L = 15 pF$	1 Mbps	I_{CCA}		7.3		9.2
			I_{CCB}		5.9		7.9
		10 Mbps	I_{CCA}		8.9		10.8
			I_{CCB}		7.9		10.0
		100 Mbps	$I_{CCA}^{(1)}$		11.9	15.2	
			$I_{CCB}^{(1)}$		22	24.4	
AL9942							
Supply current - DC signal	$V_I = 0 V$ (AL994xF)	I_{CCA}, I_{CCB}		3.2	4.8	mA	
	$V_I = V_{CCi}$ (AL994x)						
	$V_I = V_{CCi}$ (AL994xF)	I_{CCA}, I_{CCB}		9.7	13.4		
	$V_I = 0 V$ (AL994x)						
Supply current - AC signal	All channels switching with square wave clock input; $C_L = 15 pF$			6.4	8.8		
							1 Mbps
						10 Mbps	
				7.6	10.5		
				16.7	23.1		

(1) Provided by bench test and design simulation.

(2) V_{CCi} is the VCC of V_I

Timing Specifications-3.3 V Supply

$V_{CCA} = V_{CCB} = 3.3 \text{ V} \pm 10\%$, $T_A = -40^\circ\text{C} \sim +125^\circ\text{C}$. Typical value is in $V_{CC} = 3.3 \text{ V}$, $T_A = +25^\circ\text{C}$, $C_L = 15 \text{ pF}$ to GND.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{data}	Translation data rate				150	Mpbs
t_{PLH}	Propagation delay time			12.5	22	ns
t_{PHL}	Propagation delay time			12.2	22	ns
PWD	Pulse width distortion ⁽¹⁾ $ t_{\text{PHL}} - t_{\text{PLH}} $			0.3	5	ns
$t_{\text{sk(CC)}}$	Channel-to-channel output skew time ⁽²⁾	Same direction channels			2.5	ns
$t_{\text{sk(PP)}}$	Channel-to-channel output skew time ⁽²⁾	Same direction channels			4.5	ns
t_r	Output signal rise time ⁽¹⁾			0.7	4	ns
t_f	Output signal fall time ⁽¹⁾			0.7	4	ns
t_{PHZ}	Disable propagation delay, high-to-high impedance output	$C_L = 15\text{pF}$, $R_L = 1\text{K}$		20	40	ns
t_{PLZ}	Disable propagation delay, low-to-high impedance output	$C_L = 15\text{pF}$, $R_L = 1\text{K}$		18.5	40	ns
t_{PZH}	Enable propagation delay, high impedance-to-high output	$C_L = 15\text{pF}$, $R_L = 1\text{K}$		14.9	40	ns
t_{PZL}	Enable propagation delay, high impedance-to-low output	$C_L = 15\text{pF}$, $R_L = 1\text{K}$		13.5	40	ns
Jitter	Eye jitter p-p ⁽¹⁾	$f_{\text{data}} = 100 \text{ Mbps}$		800		ps
t_{DO}	Default output delay time from input power loss	Measured from the time V_{CC} goes below 1.7 V.		30	80	ns
t_{su}	Setup time			28	80	us
t_{ie}	Time interval error ⁽¹⁾	$2^{16} - 1$ PRBS data at 100 Mbps ⁽¹⁾		2.4		ns

(1) Provided by bench test and design simulation.

(2) $t_{\text{sk(CC)}}$ & $t_{\text{sk(PP)}}$ is the skew of delay time between different channel of a single device or different devices switching in the same direction while operating at identical supply voltages, temperature, input signals and loads.

Supply Current Characteristics-3.3 V Supply

$V_{CCA} = V_{CCB} = 3.3\text{ V} \pm 10\%$, $T_A = -40^\circ\text{C} \sim +125^\circ\text{C}$. Typical value is in $V_{CC} = 3.3\text{ V}$, $T_A = +25^\circ\text{C}$, $C_L = 15\text{ pF}$ to GND.

Parameter	Description		Supply current	Min	Typ	Max	Unit
AL9940							
Supply current - DC signal	$V_I = 0\text{ V(AL994xF)}$		I_{CCA}		1.5	2.7	mA
	$V_I = V_{CCi(AL994x)}$		I_{CCB}		3.1	7	
	$V_I = V_{CCi(AL994xF)}$		I_{CCA}		8.7	24	
	$V_I = 0\text{ V(AL994x)}$		I_{CCB}		3.4	6.5	
Supply current - AC signal	All channels switching with square wave clock input; $C_L = 15\text{ pF}$	1 Mbps	I_{CCA}		7.8	13.1	
			I_{CCB}		4.4	6.5	
		10 Mbps	I_{CCA}		8.1	15	
			I_{CCB}		5.6	8	
		100 Mbps	$I_{CCA}^{(1)}$		9.6	13.3	
			$I_{CCB}^{(1)}$		16.6	23.0	
AL9941							
Supply current - DC signal	$V_I = 0\text{ V(AL994xF)}$		I_{CCA}		2.7	3.9	mA
	$V_I = V_{CCi(AL994x)}$		I_{CCB}		4.3	6.2	
	$V_I = V_{CCi(AL994xF)}$		I_{CCA}		12.0	15.0	
	$V_I = 0\text{ V(AL994x)}$		I_{CCB}		6.9	9.0	
Supply current - AC signal	All channels switching with square wave clock input; $C_L = 15\text{ pF}$	1 Mbps	I_{CCA}		7.2	9.0	
			I_{CCB}		5.7	7.7	
		10 Mbps	I_{CCA}		8.4	10.4	
			I_{CCB}		7.1	9.1	
		100 Mbps	$I_{CCA}^{(1)}$		10.7	14.8	
			$I_{CCB}^{(1)}$		15.4	21.3	
AL9942							
Supply current - DC signal	$V_I = 0\text{ V(AL994xF)}$		I_{CCA}, I_{CCB}		3.2	4.4	mA
	$V_I = V_{CCi(AL994x)}$		I_{CCA}, I_{CCB}		9.1	12.6	
Supply current - AC signal	All channels switching with square wave clock input; $C_L = 15\text{ pF}$	1 Mbps	I_{CCA}, I_{CCB}		6.3	8.7	
			I_{CCA}, I_{CCB}		7.0	9.7	
		100 Mbps	$I_{CCA}, I_{CCB}^{(1)}$		13.1	18.1	

(1) Provided by bench test and design simulation

(2) V_{CCi} is the VCC of V_I

Timing Specifications-2.5 V Supply

$V_{CCA} = V_{CCB} = 2.5 \text{ V} \pm 10\%$, $T_A = -40^\circ\text{C} \sim +125^\circ\text{C}$. Typical value is in $V_{CC} = 2.5 \text{ V}$, $T_A = +25^\circ\text{C}$, $C_L = 15 \text{ pF}$ to GND.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{data}	Translation data rate				150	Mpbs
t_{PLH}	Propagation delay time			13.5	22	ns
t_{PHL}	Propagation delay time			12.2	22	ns
PWD	Pulse width distortion ⁽¹⁾ $ t_{\text{PHL}} - t_{\text{PLH}} $			1.3	5	ns
$t_{\text{sk(CC)}}$	Channel-to-channel output skew time ⁽²⁾	Same direction channels			2.5	ns
$t_{\text{sk(PP)}}$	Channel-to-channel output skew time ⁽²⁾	Same direction channels			4.5	ns
t_r	Output signal rise time ⁽¹⁾			0.7	4	ns
t_f	Output signal fall time ⁽¹⁾			0.7	4	ns
t_{PHZ}	Disable propagation delay, high-to-high impedance output	$C_L = 15\text{pF}$, $R_L = 1\text{K}$		24.5	40	ns
t_{PLZ}	Disable propagation delay, low-to-high impedance output	$C_L = 15\text{pF}$, $R_L = 1\text{K}$		21.5	40	ns
t_{PZH}	Enable propagation delay, high impedance-to-high output	$C_L = 15\text{pF}$, $R_L = 1\text{K}$		20	40	ns
t_{PZL}	Enable propagation delay, high impedance-to-low output	$C_L = 15\text{pF}$, $R_L = 1\text{K}$		17.7	40	ns
Jitter	Eye jitter p-p ⁽¹⁾	$f_{\text{data}} = 100 \text{ Mbps}$		800		ps
t_{DO}	Default output delay time from input power loss	Measured from the time V_{CC} goes below 1.7 V.		30	80	ns
t_{su}	Setup time			28	80	us
t_{ie}	Time interval error ⁽¹⁾	$2^{16} - 1$ PRBS data at 100 Mbps ⁽¹⁾		2.4		ns

(1) Provided by bench test and design simulation.

(2) $t_{\text{sk(CC)}}$ & $t_{\text{sk(PP)}}$ is the skew of delay time between different channel of a single device or different devices switching in the same direction while operating at identical supply voltages, temperature, input signals and loads.

Supply Current Characteristics-2.5 V Supply

$V_{CCA} = V_{CCB} = 2.5 V \pm 10\%$, $T_A = -40^{\circ}C \sim +125^{\circ}C$. Typical value is in $V_{CC} = 2.5 V$, $T_A = +25^{\circ}C$, $C_L = 15 pF$ to GND.

Parameter	Description		Supply current	Min	Typ	Max	Unit
AL9940							
Supply current - DC signal	$V_I = 0 V(AL994xF)$		I_{CCA}		1.4	2.7	mA
	$V_I = V_{CCi}(AL994x)$		I_{CCB}		3.1	7	
	$V_I = V_{CCi}(AL994xF)$		I_{CCA}		8.4	18	
	$V_I = 0 V(AL994x)$		I_{CCB}		3.2	6.5	
Supply current - AC signal	All channels switching with square wave clock input; $C_L = 15 pF$	1 Mbps	I_{CCA}		7.7	13.1	
			I_{CCB}		4.5	6.5	
		10 Mbps	I_{CCA}		8.1	10	
			I_{CCB}		5.4	8	
		100 Mbps	$I_{CCA}^{(1)}$		10.1	14.0	
			$I_{CCB}^{(1)}$		13.1	18.1	
AL9941							
Supply current - DC signal	$V_I = 0 V(AL994xF)$		I_{CCA}		2.7	3.8	mA
	$V_I = V_{CCi}(AL994x)$		I_{CCB}		4.3	6.2	
	$V_I = V_{CCi}(AL994xF)$		I_{CCA}		11.9	15.0	
	$V_I = 0 V(AL994x)$		I_{CCB}		6.9	8.9	
Supply current - AC signal	All channels switching with square wave clock input; $C_L = 15 pF$	1 Mbps	I_{CCA}		7.2	9.0	
			I_{CCB}		5.7	7.7	
		10 Mbps	I_{CCA}		8.2	10.1	
			I_{CCB}		6.8	8.8	
		100 Mbps	$I_{CCA}^{(1)}$		10.9	15.1	
			$I_{CCB}^{(1)}$		13.4	18.6	
AL9942							
Supply current - DC signal	$V_I = 0 V(AL994xF)$		I_{CCA}, I_{CCB}		3.2	4.4	mA
	$V_I = V_{CCi}(AL994x)$		I_{CCA}, I_{CCB}		8.3	11.5	
Supply current - AC signal	All channels switching with square wave clock input; $C_L = 15 pF$	1 Mbps	I_{CCA}, I_{CCB}		6.3	8.7	
		10 Mbps	I_{CCA}, I_{CCB}		6.8	9.4	
		100 Mbps	$I_{CCA}, I_{CCB}^{(1)}$		11.3	15.6	

(1) Provided by bench test and design simulation

(2) V_{CCi} is the VCC of V_I

Test Circuits and Waveforms

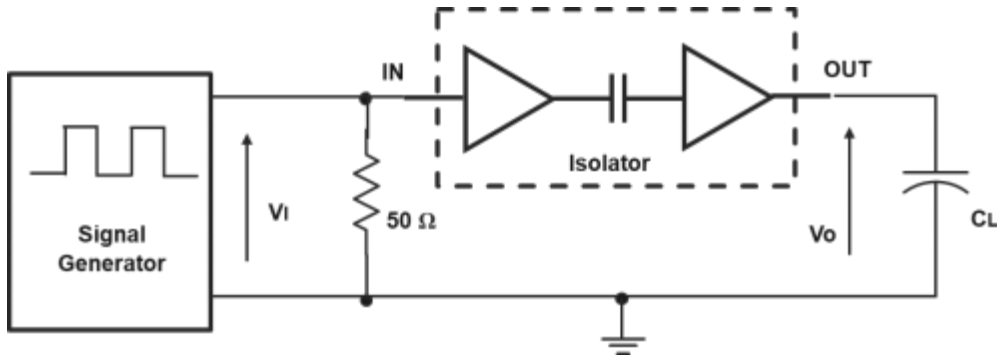


Figure 1 AC Characteristics Test Circuit

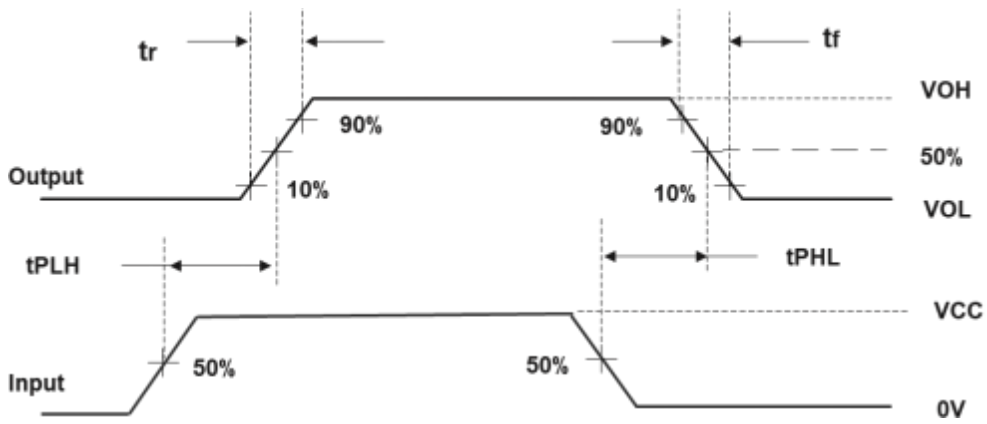


Figure 2 Timing Characteristics Voltage Waveforms

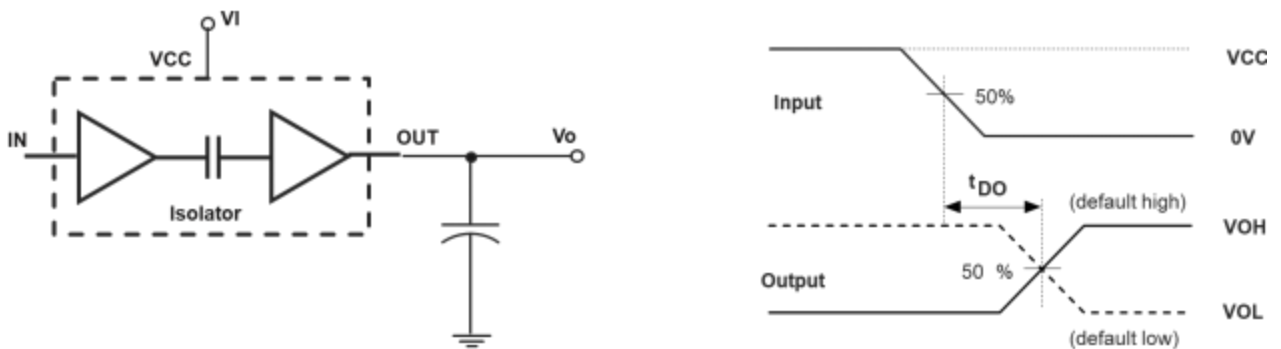


Figure 3 Default Output Delay Time Test Circuit and Voltage Waveforms

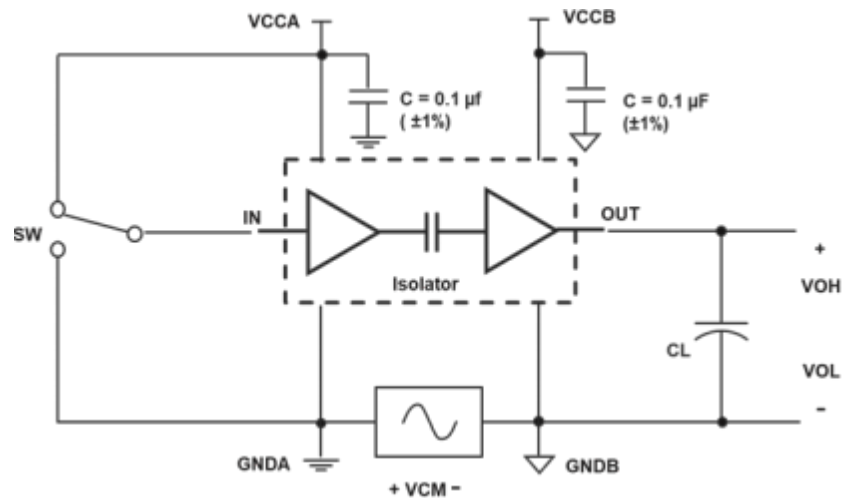


Figure 4 Common-Mode Transient Immunity Test Circuit

Detailed Description

Overview

The AL994x family design an ON-OFF keying (OOK) modulation circuit to transmit the digital data by the isolation barrier. The transmitter sends a high frequency carrier across the barrier to represent one digital state and sends no signal to represent the other digital state. The receiver demodulates the signal after advanced signal conditioning and produces the output through a buffer stage, which builds in an H-CMTI (High-performance Common-mode transient immunity) circuit to protect the normal signal transmission and minimize the radiated emissions due to the high-frequency carrier and IO buffer switching. The block diagram of a digital capacitive isolator shows a functional block diagram of a typical channel in Figure 12.

Function Block Diagram

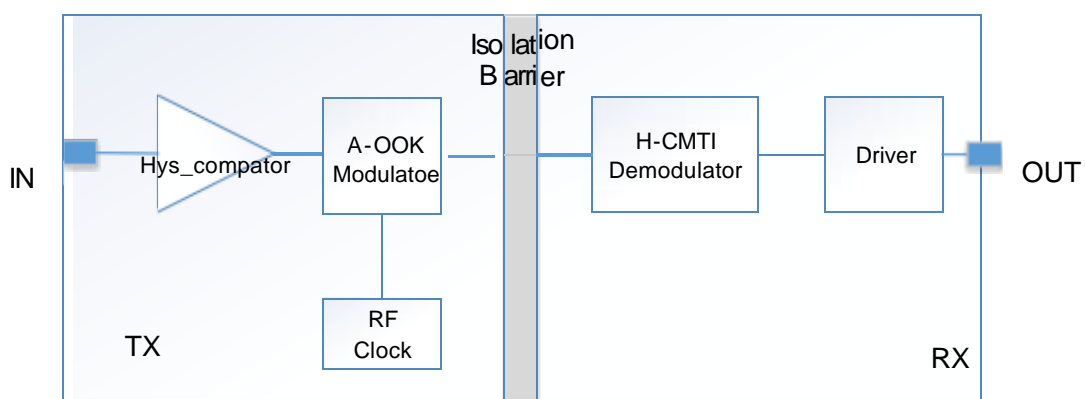


Figure 5 Conceptual Block Diagram of a Digital Capacitive Isolator

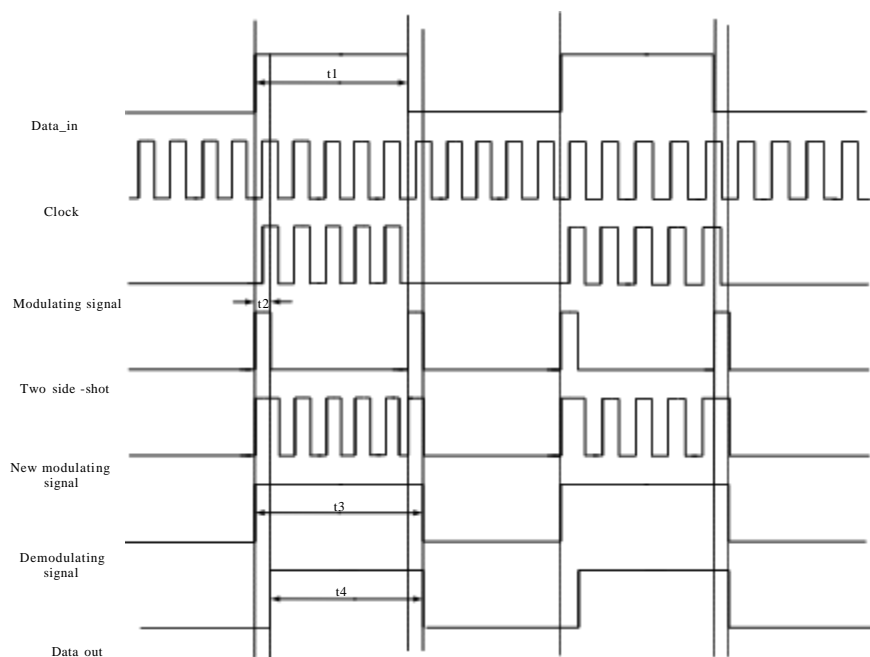


Figure 6 On-Off Keying (OOK) Based Modulation Scheme

Feature Description

The AL994x family of devices is available in two channel configurations and default output state options to enable a variety of application uses. Table 1 lists the device features of the AL994x devices.

Part Number	Max Data rate	Channel Direction	Default Output State	Package	Rating Isolation
AL9940	150 Mbps	4 Forward, 0 Reverse	High	WSOP16	5000 VRMS / 8000 VPK
				QSOP16	3750 VRMS / 5250 VPK
				SOP16	3750 VRMS / 5250 VPK
AL9940F	150 Mbps	4 Forward, 0 Reverse	Low	WSOP16	5000 VRMS / 8000 VPK
				QSOP16	3750 VRMS / 5250 VPK
				SOP16	3750 VRMS / 5250 VPK
AL9941	150 Mbps	3 Forward, 1 Reverse	High	WSOP16	5000 VRMS / 8000 VPK
				QSOP16	3750 VRMS / 5250 VPK
				SOP16	3750 VRMS / 5250 VPK
AL9941F	150 Mbps	3 Forward, 1 Reverse	Low	WSOP16	5000 VRMS / 8000 VPK
				QSOP16	3750 VRMS / 5250 VPK
				SOP16	3750 VRMS / 5250 VPK
AL9942	150 Mbps	2 Forward, 2 Reverse	High	WSOP16	5000 VRMS / 8000 VPK
				QSOP16	3750 VRMS / 5250 VPK
				SOP16	3750 VRMS / 5250 VPK
AL9942F	150 Mbps	2 Forward, 2 Reverse	Low	WSOP16	5000 VRMS / 8000 VPK
				QSOP16	3750 VRMS / 5250 VPK
				SOP16	3750 VRMS / 5250 VPK

Device Functional Modes

The below table lists the functional modes for the AL994x devices.

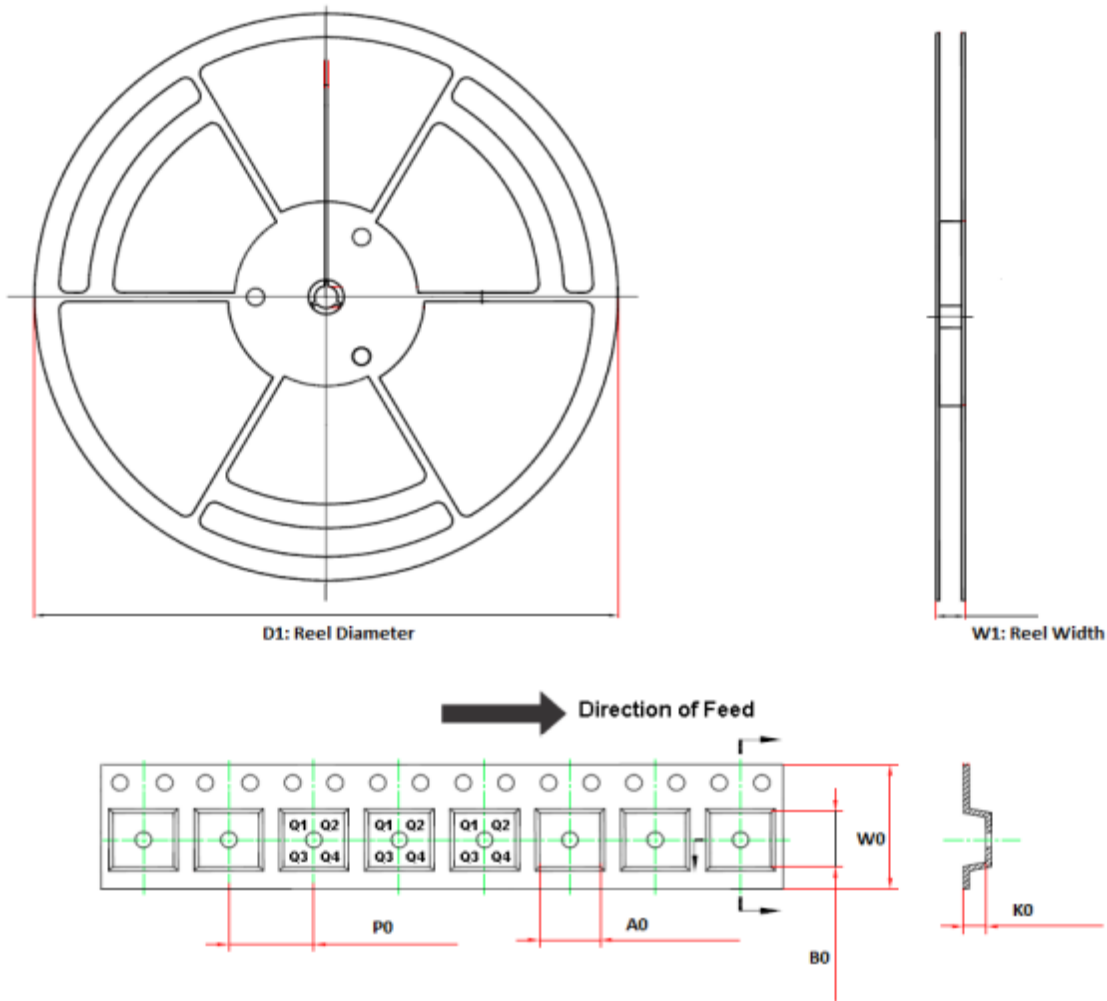
VCC _i	VCC _o	Input (IN1, IN2)	Output (OUT1, OUT2)	Comments
PU	PU	H	H	Normal Operation: A channel output assumes the logic state of the input.
		L	L	
		Open	Default	Default mode: When IN _x is open, the corresponding channel output goes to the default logic state. The default is High for AL994x and Low for AL994xF
PD	PU	X	Default	Default mode: When VCC _i is unpowered, the default is High for AL994x and Low for AL994xF When VCC _i transitions from unpowered to powered-up, a channel output assumes the logic state of the input. When VCC _i transitions from powered-up to unpowered, channel output assumes the selected default state.

X	PD	X	Undetermined	When VCC _O is unpowered, a channel output is undetermined. When VCC _O transitions from unpowered to powered-up, a channel output assumes the logic state of the input
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(1) VCC_I = Input-side V_{CCA}; VCC_O = Output-side V_{CCB}; PU = Powered up (V_{CC} ≥ 2.25 V); PD = Powered down (V_{CC} ≤ 1.7 V); X = Irrelevant; H = High level; L = Low level

(2) The outputs are in the undetermined state when 1.7 V < VCC_I, VCC_O < 2.25 V.

Tape and Reel Information

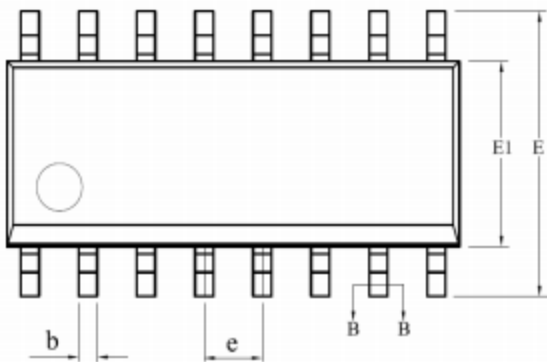
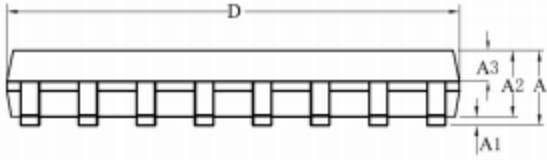


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
AL9940-SO3R	16-Pin SOP	330	21.6	6.7	10.4	2.1	8.0	16.0	Q1
AL9940F-SO3R	16-Pin SOP	330	21.6	6.7	10.4	2.1	8.0	16.0	Q1
AL9941-SO3R	16-Pin SOP	330	21.6	6.7	10.4	2.1	8.0	16.0	Q1
AL9941F-SO3R	16-Pin SOP	330	21.6	6.7	10.4	2.1	8.0	16.0	Q1
AL9942-SO3R	16-Pin SOP	330	21.6	6.7	10.4	2.1	8.0	16.0	Q1
AL9942F-SO3R	16-Pin SOP	330	21.6	6.7	10.4	2.1	8.0	16.0	Q1

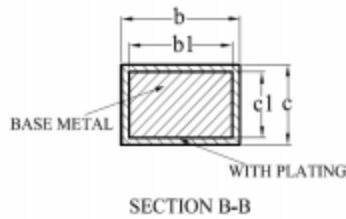
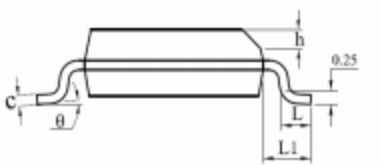
AL9940-SSAR	16-Pin QSOP	330	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL9940F-SSAR	16-Pin QSOP	330	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL9941-SSAR	16-Pin QSOP	330	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL9941F-SSAR	16-Pin QSOP	330	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL9942-SSAR	16-Pin QSOP	330	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL9942F-SSAR	16-Pin QSOP	330	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL9940-SOBR	16-Pin WSOP	330	22.4	10.9	10.8	3.0	12.0	16.0	Q1
AL9940F-SOBR	16-Pin WSOP	330	22.4	10.9	10.8	3.0	12.0	16.0	Q1
AL9941-SOBR	16-Pin WSOP	330	22.4	10.9	10.8	3.0	12.0	16.0	Q1
AL9941F-SOBR	16-Pin WSOP	330	22.4	10.9	10.8	3.0	12.0	16.0	Q1
AL9942-SOBR	16-Pin WSOP	330	22.4	10.9	10.8	3.0	12.0	16.0	Q1
AL9942F-SOBR	16-Pin WSOP	330	22.4	10.9	10.8	3.0	12.0	16.0	Q1
AL9940-SO3R-S	16-Pin SOP	330	21.6	6.7	10.4	2.1	8.0	16.0	Q1
AL9940F-SO3R-S	16-Pin SOP	330	21.6	6.7	10.4	2.1	8.0	16.0	Q1
AL9941-SO3R-S	16-Pin SOP	330	21.6	6.7	10.4	2.1	8.0	16.0	Q1
AL9941F-SO3R-S	16-Pin SOP	330	21.6	6.7	10.4	2.1	8.0	16.0	Q1
AL9942-SO3R-S	16-Pin SOP	330	21.6	6.7	10.4	2.1	8.0	16.0	Q1
AL9942F-SO3R-S	16-Pin SOP	330	21.6	6.7	10.4	2.1	8.0	16.0	Q1
AL9940-SSAR-S	16-Pin QSOP	330	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL9940F-SSAR-S	16-Pin QSOP	330	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL9941-SSAR-S	16-Pin QSOP	330	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL9941F-SSAR-S	16-Pin QSOP	330	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL9942-SSAR-S	16-Pin QSOP	330	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL9942F-SSAR-S	16-Pin QSOP	330	17.6	6.4	5.4	2.1	8.0	12.0	Q1
AL9940-SOBR-S	16-Pin WSOP	330	22.4	10.9	10.8	3.0	12.0	16.0	Q1
AL9940F-SOBR-S	16-Pin WSOP	330	22.4	10.9	10.8	3.0	12.0	16.0	Q1
AL9941-SOBR-S	16-Pin WSOP	330	22.4	10.9	10.8	3.0	12.0	16.0	Q1
AL9941F-SOBR-S	16-Pin WSOP	330	22.4	10.9	10.8	3.0	12.0	16.0	Q1
AL9942-SOBR-S	16-Pin WSOP	330	22.4	10.9	10.8	3.0	12.0	16.0	Q1
AL9942F-SOBR-S	16-Pin WSOP	330	22.4	10.9	10.8	3.0	12.0	16.0	Q1

Package Outline Dimensions

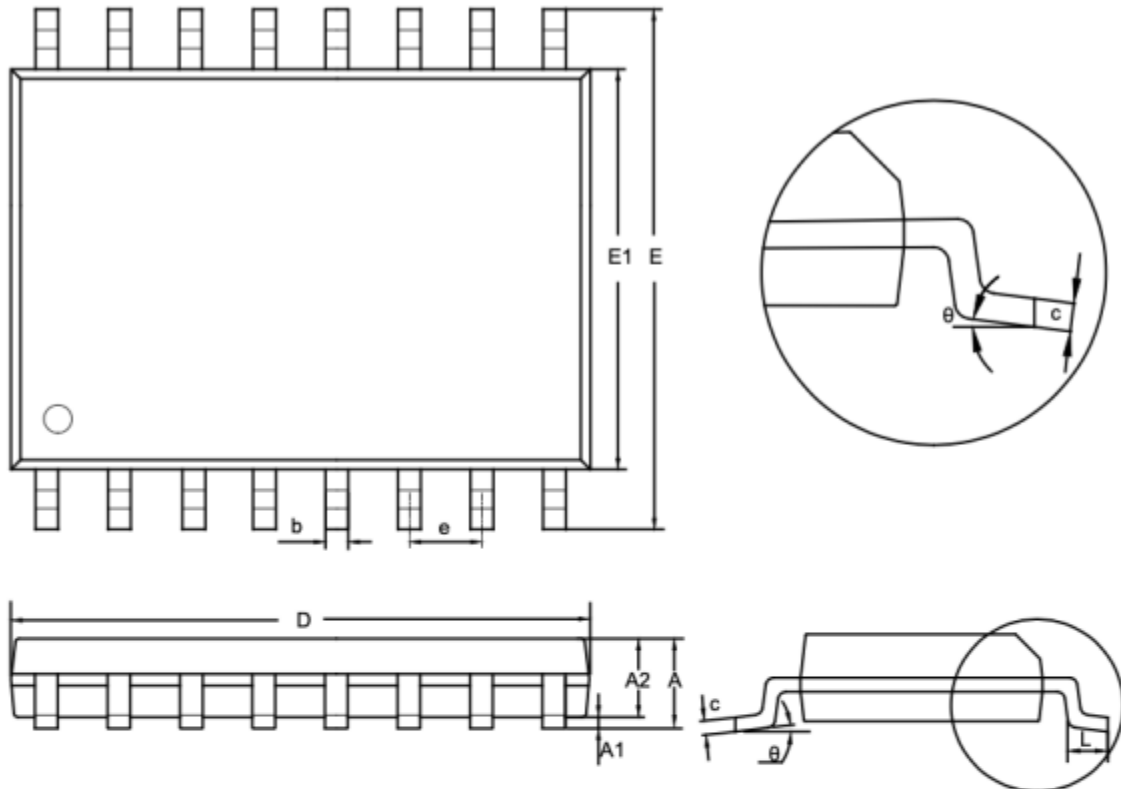
SO3R (SOP-16)



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
A1	0.10	—	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	9.80	9.90	10.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05REF		
θ	0	—	8°



SSAR (QSOP16)

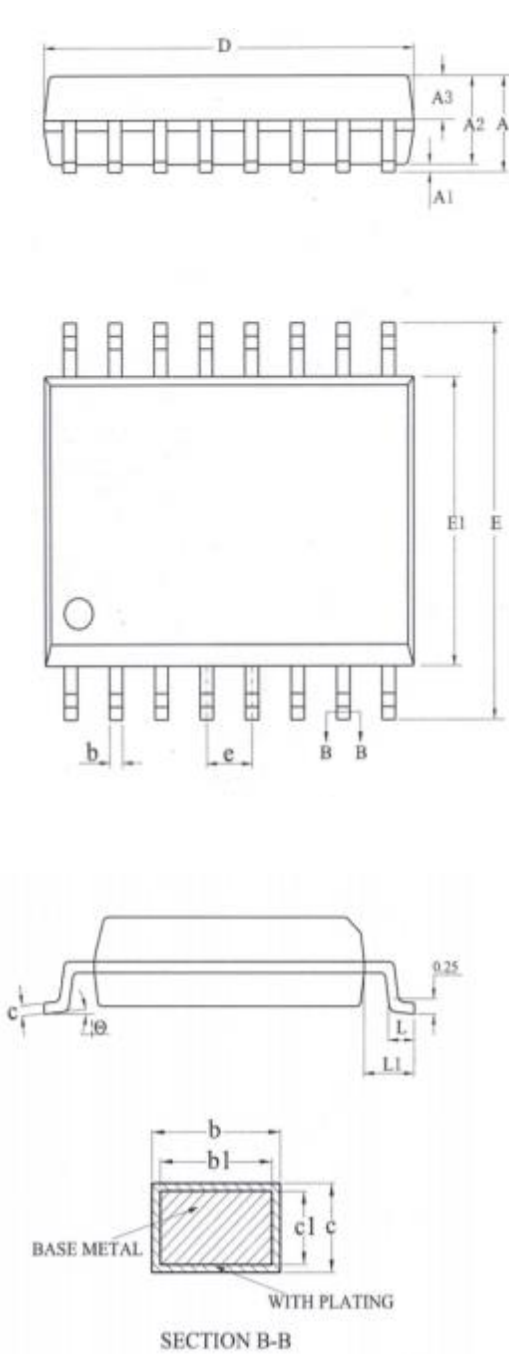


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.300	1.500	0.051	0.059
b	0.230	0.310	0.009	0.012
c	0.170	0.250	0.007	0.010
D	4.800	5.000	0.189	0.197
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	0.635 BSC		0.025 BSC	
L	0.400	0.800	0.016	0.031
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

SOBR (WSOP16)



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	2.65
A1	0.10	—	0.30
A2	2.25	2.30	2.35
A3	0.97	1.02	1.07
b	0.35	—	0.44
b1	0.34	0.37	0.39
c	0.25	—	0.31
c1	0.24	0.25	0.26
D	10.10	10.30	10.50
E	10.26	10.41	10.60
E1	7.30	7.50	7.70
e	1.27BSC		
L	0.55	—	0.85
L1	1.40BSC		
θ	0	—	8°

△ △

△

Order Information

Order Number	Operating Temperature Range	Package	MSL	Transport Media, Quantity	Eco Plan
AL9940-SO3R	-40 to 125°C	16-Pin SOP	MSL3	Tape and Reel, 2500	Green
AL9940F-SO3R	-40 to 125°C	16-Pin SOP	MSL3	Tape and Reel, 2500	Green
AL9941-SO3R	-40 to 125°C	16-Pin SOP	MSL3	Tape and Reel, 2500	Green
AL9941F-SO3R	-40 to 125°C	16-Pin SOP	MSL3	Tape and Reel, 2500	Green
AL9942-SO3R	-40 to 125°C	16-Pin SOP	MSL3	Tape and Reel, 2500	Green
AL9942F-SO3R	-40 to 125°C	16-Pin SOP	MSL3	Tape and Reel, 2500	Green
AL9940-SSAR	-40 to 125°C	16-Pin QSOP	MSL3	Tape and Reel, 1500	Green
AL9940F-SSAR	-40 to 125°C	16-Pin QSOP	MSL3	Tape and Reel, 1500	Green
AL9941-SSAR	-40 to 125°C	16-Pin QSOP	MSL3	Tape and Reel, 1500	Green
AL9941F-SSAR	-40 to 125°C	16-Pin QSOP	MSL3	Tape and Reel, 1500	Green
AL9942-SSAR	-40 to 125°C	16-Pin QSOP	MSL3	Tape and Reel, 1500	Green
AL9942F-SSAR	-40 to 125°C	16-Pin QSOP	MSL3	Tape and Reel, 1500	Green
AL9940-SOBR	-40 to 125°C	16-Pin WSOP	MSL3	Tape and Reel, 1500	Green
AL9940F-SOBR	-40 to 125°C	16-Pin WSOP	MSL3	Tape and Reel, 1500	Green
AL9941-SOBR	-40 to 125°C	16-Pin WSOP	MSL3	Tape and Reel, 1500	Green
AL9941F-SOBR	-40 to 125°C	16-Pin WSOP	MSL3	Tape and Reel, 1500	Green
AL9942-SOBR	-40 to 125°C	16-Pin WSOP	MSL3	Tape and Reel, 1500	Green
AL9942F-SOBR	-40 to 125°C	16-Pin WSOP	MSL3	Tape and Reel, 1500	Green
AL9940-SO3R-S	-40 to 125°C	16-Pin SOP	MSL3	Tape and Reel, 2500	Green
AL9940F-SO3R-S	-40 to 125°C	16-Pin SOP	MSL3	Tape and Reel, 2500	Green
AL9941-SO3R-S	-40 to 125°C	16-Pin SOP	MSL3	Tape and Reel, 2500	Green
AL9941F-SO3R-S	-40 to 125°C	16-Pin SOP	MSL3	Tape and Reel, 2500	Green

AL9942-SO3R-S	-40 to 125°C	16-Pin SOP	MSL3	Tape and Reel, 2500	Green
AL9942F-SO3R-S	-40 to 125°C	16-Pin SOP	MSL3	Tape and Reel, 2500	Green
AL9940-SSAR-S	-40 to 125°C	16-Pin QSOP	MSL3	Tape and Reel, 1500	Green
AL9940F-SSAR-S	-40 to 125°C	16-Pin QSOP	MSL3	Tape and Reel, 1500	Green
AL9941-SSAR-S	-40 to 125°C	16-Pin QSOP	MSL3	Tape and Reel, 1500	Green
AL9941F-SSAR-S	-40 to 125°C	16-Pin QSOP	MSL3	Tape and Reel, 1500	Green
AL9942-SSAR-S	-40 to 125°C	16-Pin QSOP	MSL3	Tape and Reel, 1500	Green
AL9942F-SSAR-S	-40 to 125°C	16-Pin QSOP	MSL3	Tape and Reel, 1500	Green
AL9940-SOBR-S	-40 to 125°C	16-Pin WSOP	MSL3	Tape and Reel, 1500	Green
AL9940F-SOBR-S	-40 to 125°C	16-Pin WSOP	MSL3	Tape and Reel, 1500	Green
AL9941-SOBR-S	-40 to 125°C	16-Pin WSOP	MSL3	Tape and Reel, 1500	Green
AL9941F-SOBR-S	-40 to 125°C	16-Pin WSOP	MSL3	Tape and Reel, 1500	Green
AL9942-SOBR-S	-40 to 125°C	16-Pin WSOP	MSL3	Tape and Reel, 1500	Green
AL9942F-SOBR-S	-40 to 125°C	16-Pin WSOP	MSL3	Tape and Reel, 1500	Green