

SN55110A, SN75110A, SN75112 DUAL LINE DRIVERS

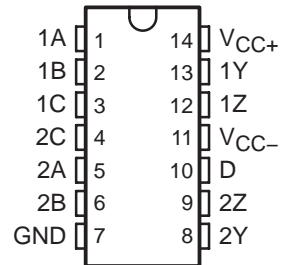
SLLS106G – DECEMBER 1975 – REVISED NOVEMBER 2004

- Improved Stability Over Supply Voltage and Temperature Ranges
- Constant-Current Outputs
- High Speed
- Standard Supply Voltages
- High Output Impedance
- High Common-Mode Output Voltage Range
... -3 V to 10 V
- TTL-Input Compatibility
- Inhibitor Available for Driver Selection
- Glitch Free During Power Up/Power Down
- SN75112 and External Circuit Meets or Exceeds the Requirements of CCITT Recommendation V.35

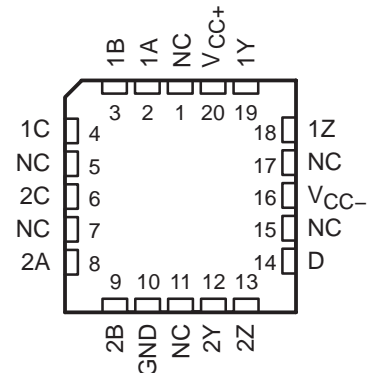
description/ordering information

The SN55110A, SN75110A, and SN75112 dual line drivers have improved output current regulation with supply-voltage and temperature variations. In addition, the higher current of the SN75112 (27 mA) allows data to be transmitted over longer lines. These drivers offer optimum performance when used with the SN55107A, SN75107A, and SN75108A line receivers.

SN55110A ... J OR W PACKAGE
SN75110A ... D, N, OR NS PACKAGE
SN75112 ... D OR N PACKAGE
(TOP VIEW)



SN55110A ... FK PACKAGE
(TOP VIEW)



NC – No internal connection

ORDERING INFORMATION

TA	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	PDIP (N)	Tube of 25	SN75110AN	SN75110AN
		Tube of 50	SN75112N	SN75112N
	SOIC (D)	Reel of 2500	SN75110AD	SN75110A
		Tube of 50	SN75112D	
		Reel of 2500	SN75112DR	SN75112
		SOP (NS)	Reel of 2000	
-55°C to 125°C	CDIP (J)	Tube of 25	SN55110AJ	SN55110AJ
		Tube of 150	SNJ55110AJ	SNJ55110AJ
	CFP (W)	Tube of 150	SNJ55110AW	SNJ55110AW
	LCCC (FK)	Tube of 55	SNJ55110AFK	SNJ55110AFK

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2004, Texas Instruments Incorporated
On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

SN55110A, SN75110A, SN75112 DUAL LINE DRIVERS

SLLS106G – DECEMBER 1975 – REVISED NOVEMBER 2004

description/ordering information (continued)

These drivers feature independent channels with common voltage supply and ground terminals. The significant difference between the three drivers is in the output-current specification. The driver circuits feature a constant output current that is switched to either of two output terminals by the appropriate logic levels at the input terminals. The output current can be switched off (inhibited) by low logic levels on the enable inputs. The output current nominally is 12 mA for the '110A devices and is 27 mA for the SN75112.

The enable/inhibit feature is provided so the circuits can be used in party-line or data-bus applications. A strobe or inhibitor (enable D), common to both drivers, is included for increased driver-logic versatility. The output current in the inhibited mode, $I_{O(off)}$, is specified so that minimum line loading is induced when the driver is used in a party-line system with other drivers. The output impedance of the driver in the inhibited mode is very high. The output impedance of a transistor is biased to cutoff.

The driver outputs have a common-mode voltage range of -3 V to 10 V , allowing common-mode voltage on the line without affecting driver performance.

All inputs are diode clamped and are designed to satisfy TTL-system requirements. The inputs are tested at 2 V for high-logic-level input conditions and 0.8 V for low-logic-level input conditions. These tests ensure 400-mV noise margin when interfaced with TTL Series 54/74 devices.

The SN55110A is characterized for operation over the full military temperature range of -55°C to 125°C . The SN75110A and SN75112 are characterized for operation from 0°C to 70°C .

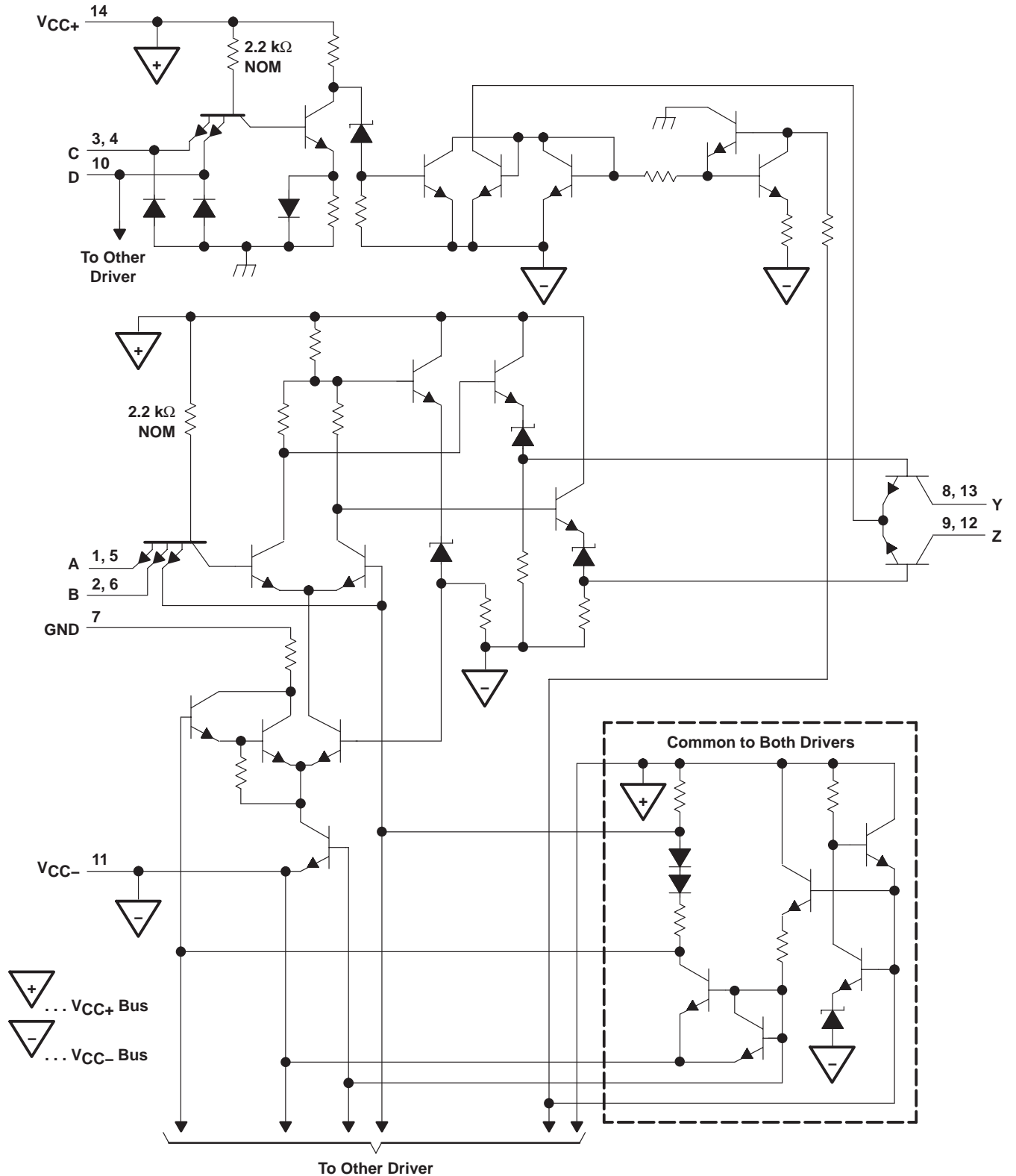
FUNCTION TABLE
(each driver)

LOGIC INPUTS		ENABLE INPUTS		OUTPUTS†	
A	B	C	D	Y	Z
X	X	L	X	Off	Off
X	X	X	L	Off	Off
L	X	H	H	On	Off
X	L	H	H	On	Off
H	H	H	H	Off	On

H = high level, L = low level, X = irrelevant

† When using only one channel of the line drivers, the other channel should be inhibited and/or have its outputs grounded.

schematic (each driver)



Pin numbers shown are for the D, J, N, NS, and W packages.

SN55110A, SN75110A, SN75112 DUAL LINE DRIVERS

SLLS106G – DECEMBER 1975 – REVISED NOVEMBER 2004

absolute maximum ratings over operating free-air temperature (unless otherwise noted)†

Supply voltage: V_{CC+} (see Note 1)	7 V
V_{CC-} (see Note 1)	-7 V
Input voltage, V_I	5.5 V
Output voltage range, V_O	-5 V to 12 V
Package thermal impedance, θ_{JA} (see Notes 2 and 3): D package	86°C/W
N package	80°C/W
NS package	76°C/W
Package thermal impedance, θ_{JC} (see Notes 4 and 5): FK package	13.42°C/W
J package	15.05°C/W
W package	14.65°C/W
Operating virtual junction temperature	150°C
Case temperature for 60 seconds: FK package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: J or W package	300°C
Storage temperature range, T_{stg}	-65°C to 150°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES:
1. Voltage values are with respect to network ground terminal.
 2. Maximum power dissipation is a function of $T_J(\text{max})$, θ_{JA} , and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
 3. The package thermal impedance is calculated in accordance with JESD 51-7.
 4. Maximum power dissipation is a function of $T_J(\text{max})$, θ_{JC} , and T_C . The maximum allowable power dissipation at any allowable case temperature is $P_D = (T_J(\text{max}) - T_C)/\theta_{JC}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
 5. The package thermal impedance is calculated in accordance with MIL-STD-883.

recommended operating conditions (see Note 6)

	SN55110A			SN75110A SN75112			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC+} Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{CC-} Supply voltage	-4.5	-5	-5.5	-4.75	-5	-5.25	V
Positive common-mode output voltage	0		10	0		10	V
Negative common-mode output voltage	0		-3	0		-3	V
V_{IH} High-level input voltage	2			2			V
V_{IL} Low-level output voltage			0.8			0.8	V
T_A Operating free-air temperature	-55		125	0		70	°C

NOTE 6: When using only one channel of the line drivers, the other channel should be inhibited and/or have its outputs grounded.



SN55110A, SN75110A, SN75112 DUAL LINE DRIVERS

SLLS106G – DECEMBER 1975 – REVISED NOVEMBER 2004

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	SN55110A SN75110A			SN75112			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	Input clamp voltage	$V_{CC\pm} = \text{MIN}, I_L = -12 \text{ mA}$	-0.9	-1.5		-0.9	-1.5	V	
$I_{O(\text{on})}$	On-state output current	$V_{CC\pm} = \text{MAX}, V_O = 10 \text{ V}$	12	15		27	40	mA	
		$V_{CC} = \text{MIN to MAX}, V_O = -1 \text{ V to } 1 \text{ V}, T_A = 25^\circ\text{C}$				24	28		32
		$V_{CC\pm} = \text{MIN}, V_O = -3 \text{ V}$	6.5	12		15	27		
$I_{O(\text{off})}$	Off-state output current	$V_{CC\pm} = \text{MIN}, V_O = 10 \text{ V}$			100			100	μA
I_I	Input current at maximum input voltage	A, B, or C inputs	$V_{CC\pm} = \text{MAX}, V_I = 5.5 \text{ V}$			1			1
		D input							
I_{IH}	High-level input current	A, B, or C inputs	$V_{CC\pm} = \text{MAX}, V_I = 2.4 \text{ V}$			40			40
		D input							
I_{IL}	Low-level input current	A, B, or C inputs	$V_{CC\pm} = \text{MAX}, V_I = 0.4 \text{ V}$			-3			-3
		D input							
$I_{CC+(\text{on})}$	Supply current from V_{CC} with driver enabled	$V_{CC\pm} = \text{MAX},$ A and B inputs at 0.4 V, C and D inputs at 2 V	23	35		25	40	mA	
$I_{CC-(\text{on})}$	Supply current from V_{CC-} with driver enabled	$V_{CC\pm} = \text{MAX},$ A and B inputs at 0.4 V, C and D inputs at 2 V	-34	-50		-65	-100	mA	
$I_{CC+(\text{off})}$	Supply current from V_{CC-} with driver inhibited	$V_{CC\pm} = \text{MAX},$ A, B, C, and D inputs at 0.4 V	21			30		mA	
$I_{CC-(\text{off})}$	Supply current from $V_{CC\pm}$ with driver inhibited	$V_{CC\pm} = \text{MAX},$ A, B, C, and D inputs at 0.4 V	-17			-32		mA	

† For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.

‡ All typical values are at $V_{CC+} = 5 \text{ V}, V_{CC-} = -5 \text{ V}, T_A = 25^\circ\text{C}$.

switching characteristics, $V_{CC\pm} = \pm 5 \text{ V}, T_A = 25^\circ\text{C}$ (see Figure 1)

PARAMETERS§	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{PLH}	A or B	Y or Z	$C_L = 40 \text{ pF}, R_L = 50 \Omega,$		9		15	ns
t_{PHL}					9		15	
t_{PLH}	C or D	Y or Z	$C_L = 40 \text{ pF}, R_L = 50 \Omega,$		16		25	ns
t_{PHL}					13		25	

§ t_{PLH} = propagation delay time, low- to high-level output

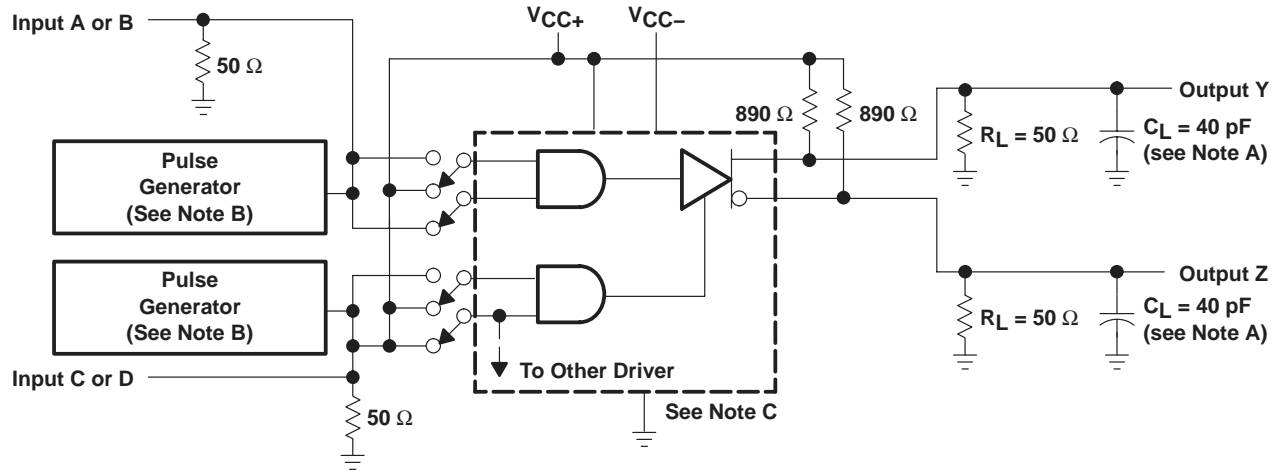
t_{PHL} = propagation delay time, high- to low-level output



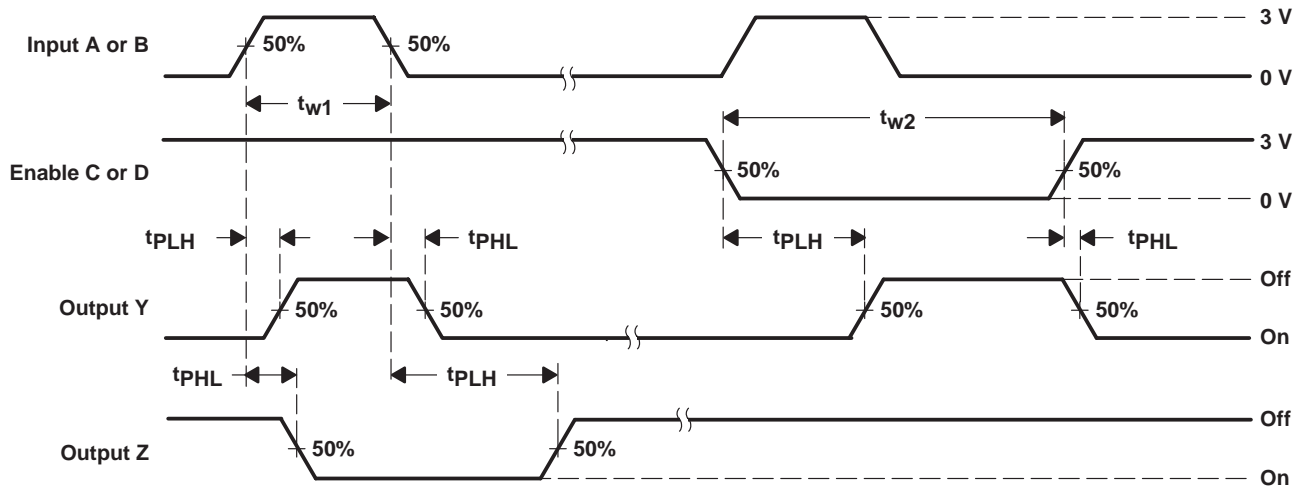
SN55110A, SN75110A, SN75112 DUAL LINE DRIVERS

SLLS106G – DECEMBER 1975 – REVISED NOVEMBER 2004

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

- NOTES: A. C_L includes probe and jig capacitance.
 B. The pulse generators have the following characteristics: $Z_O = 50 \Omega$, $t_r = t_f = 10 \pm 5 \text{ ns}$, $t_{w1} = 500 \text{ ns}$, $\text{PRR} \leq 1 \text{ MHz}$, $t_{w2} = 1 \mu\text{s}$, $\text{PRR} \leq 500 \text{ kHz}$.
 C. For simplicity, only one channel and the enable connections are shown.

Figure 1. Test Circuit and Voltage Waveforms

TYPICAL CHARACTERISTICS

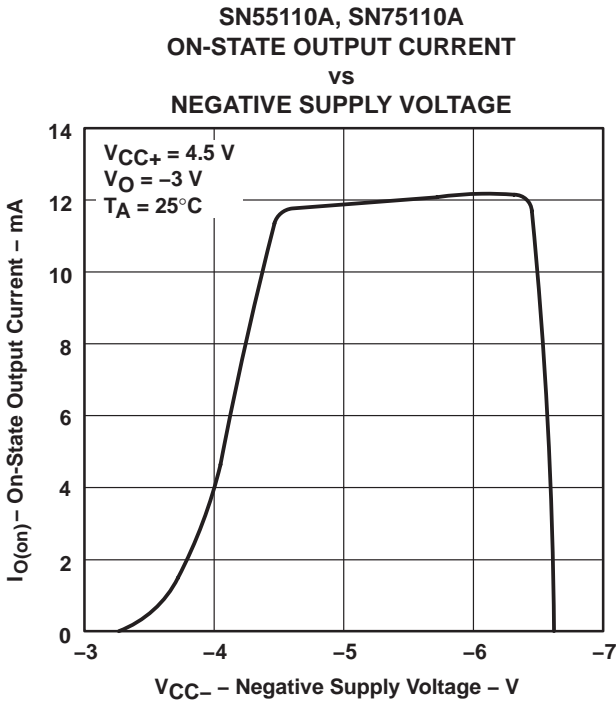


Figure 2

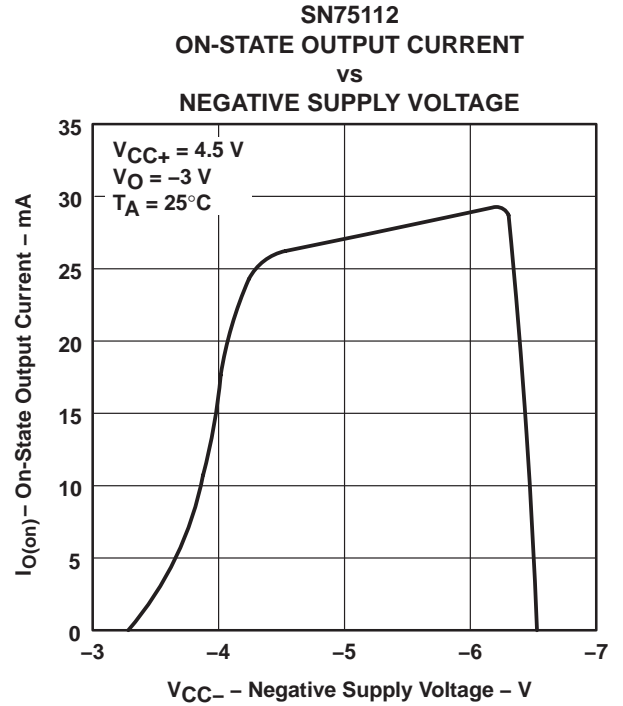


Figure 3

SN55110A, SN75110A, SN75112 DUAL LINE DRIVERS

SLLS106G – DECEMBER 1975 – REVISED NOVEMBER 2004

APPLICATION INFORMATION

special pulse-control circuit

Figure 4 shows a circuit that can be used as a pulse-generator output or in many other testing applications.

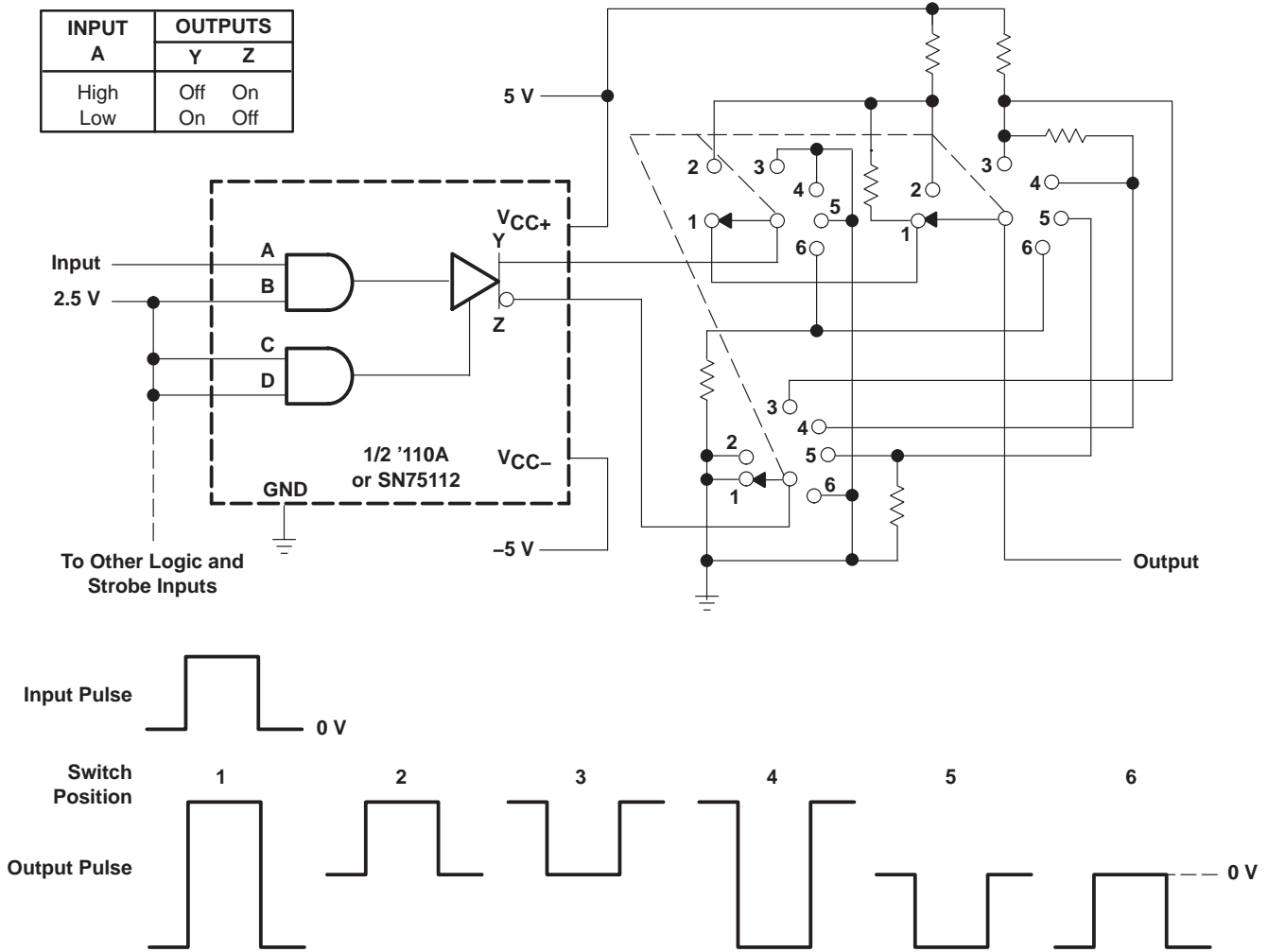


Figure 4. Pulse-Control Circuit

APPLICATION INFORMATION

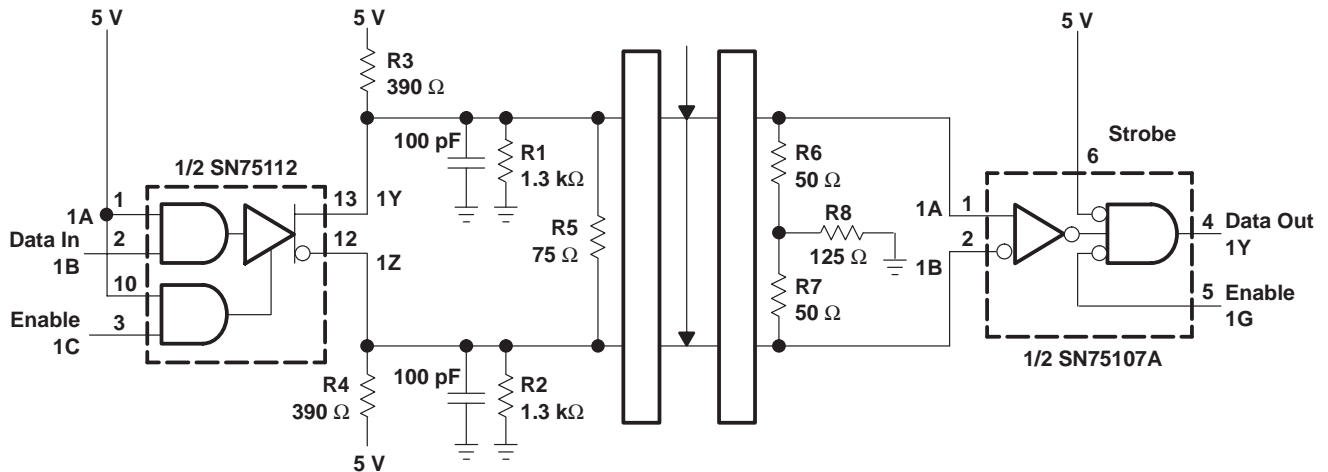
using the SN75112 as a CCITT-recommended V.35 line driver

The SN75112 dual line driver, the SN75107A dual line receiver, and some external resistors can be used to implement the data-interchange circuit of CCITT recommendation V.35 (1976) modem specification. The circuit of one channel is shown in Figure 5 and meets the requirement of the interface as specified by Appendix 11 of CCITT V.35 and is summarized in Table 1 (V.35 has been replaced by ITU V.11).

Table 1. CCITT V.35 Electrical Requirements

GENERATOR	MIN	MAX	UNIT
Source impedance, Z_{source}	50	150	Ω
Resistance to ground, R	135	165	Ω
Differential output voltage, V_{OD}	440	660	mV
10% to 90% rise time, t_r	40		ns
or	0.01 \times ui^\dagger		
Common-mode output voltage, V_{OC}	-0.6	0.6	V
LOAD (RECEIVER)	MIN	MAX	UNIT
Input impedance, Z_I	90	110	Ω
Resistance to ground, R	135	165	Ω

$\dagger ui$ = unit interval or minimum signal-element pulse duration



All resistors are 5%, 1/4 W.

Figure 5. CCITT-Recommended V.35 Interface Using the SN75112 and SN75107A

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-87547012A	ACTIVE	LCCC	FK	20	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-87547012A SNJ55110AFK	Samples
5962-8754701CA	ACTIVE	CDIP	J	14	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8754701CA SNJ55110AJ	Samples
5962-8754701DA	ACTIVE	CFP	W	14	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8754701DA SNJ55110AW	Samples
SN55110AJ	ACTIVE	CDIP	J	14	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	SN55110AJ	Samples
SN75110AD	LIFEBUY	SOIC	D	14	50	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	SN75110A	
SN75110ADR	LIFEBUY	SOIC	D	14	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	SN75110A	
SN75110AN	LIFEBUY	PDIP	N	14	25	RoHS & Green	NIPDAU	N / A for Pkg Type	0 to 70	SN75110AN	
SN75110ANS	LIFEBUY	SO	NS	14	50	RoHS & Green	NIPDAU	Level-1-260C-UNLIM		SN75110A	
SN75110ANSR	LIFEBUY	SO	NS	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	SN75110A	
SN75112D	LIFEBUY	SOIC	D	14	50	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	SN75112	
SN75112DR	LIFEBUY	SOIC	D	14	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	SN75112	
SN75112N	LIFEBUY	PDIP	N	14	25	RoHS & Green	NIPDAU	N / A for Pkg Type	0 to 70	SN75112N	
SNJ55110AFK	ACTIVE	LCCC	FK	20	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-87547012A SNJ55110AFK	Samples
SNJ55110AJ	ACTIVE	CDIP	J	14	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8754701CA SNJ55110AJ	Samples
SNJ55110AW	ACTIVE	CFP	W	14	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8754701DA SNJ55110AW	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSELETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of ≤ 1000 ppm threshold. Antimony trioxide based flame retardants must also meet the ≤ 1000 ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF SN55110A, SN75110A :

● Catalog : [SN75110A](#)

● Military : [SN55110A](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN75110ADR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
SN75110ADR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
SN75110ANSR	SO	NS	14	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
SN75112DR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN75110ADR	SOIC	D	14	2500	340.5	336.1	32.0
SN75110ADR	SOIC	D	14	2500	356.0	356.0	35.0
SN75110ANSR	SO	NS	14	2000	356.0	356.0	35.0
SN75112DR	SOIC	D	14	2500	356.0	356.0	35.0

TUBE


*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
5962-87547012A	FK	LCCC	20	1	506.98	12.06	2030	NA
5962-8754701DA	W	CFP	14	1	506.98	26.16	6220	NA
SN75110AD	D	SOIC	14	50	506.6	8	3940	4.32
SN75110AN	N	PDIP	14	25	506	13.97	11230	4.32
SN75110AN	N	PDIP	14	25	506	13.97	11230	4.32
SN75112D	D	SOIC	14	50	506.6	8	3940	4.32
SN75112N	N	PDIP	14	25	506	13.97	11230	4.32
SNJ55110AFK	FK	LCCC	20	1	506.98	12.06	2030	NA
SNJ55110AW	W	CFP	14	1	506.98	26.16	6220	NA

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

W (R-GDFP-F14)

CERAMIC DUAL FLATPACK



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package can be hermetically sealed with a ceramic lid using glass frit.
 - D. Index point is provided on cap for terminal identification only.
 - E. Falls within MIL STD 1835 GDFP1-F14

GENERIC PACKAGE VIEW

FK 20

LCCC - 2.03 mm max height

8.89 x 8.89, 1.27 mm pitch

LEADLESS CERAMIC CHIP CARRIER

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4229370VA\

J 14

GENERIC PACKAGE VIEW
CDIP - 5.08 mm max height
CERAMIC DUAL IN LINE PACKAGE



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4040083-5/G

J0014A



PACKAGE OUTLINE

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



4214771/A 05/2017

NOTES:

1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package is hermetically sealed with a ceramic lid using glass frit.
4. Index point is provided on cap for terminal identification only and on press ceramic glass frit seal only.
5. Falls within MIL-STD-1835 and GDIP1-T14.

EXAMPLE BOARD LAYOUT

J0014A

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



LAND PATTERN EXAMPLE
NON-SOLDER MASK DEFINED
SCALE: 5X



4214771/A 05/2017

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AB.

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 - The 20 pin end lead shoulder width is a vendor option, either half or full width.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2023, Texas Instruments Incorporated