SCAN16602 Low Voltage Universal 16-bit IEEE 1149.1 Bus Transceiver with TRI-STATE Outputs

Check for Samples: SCAN16602

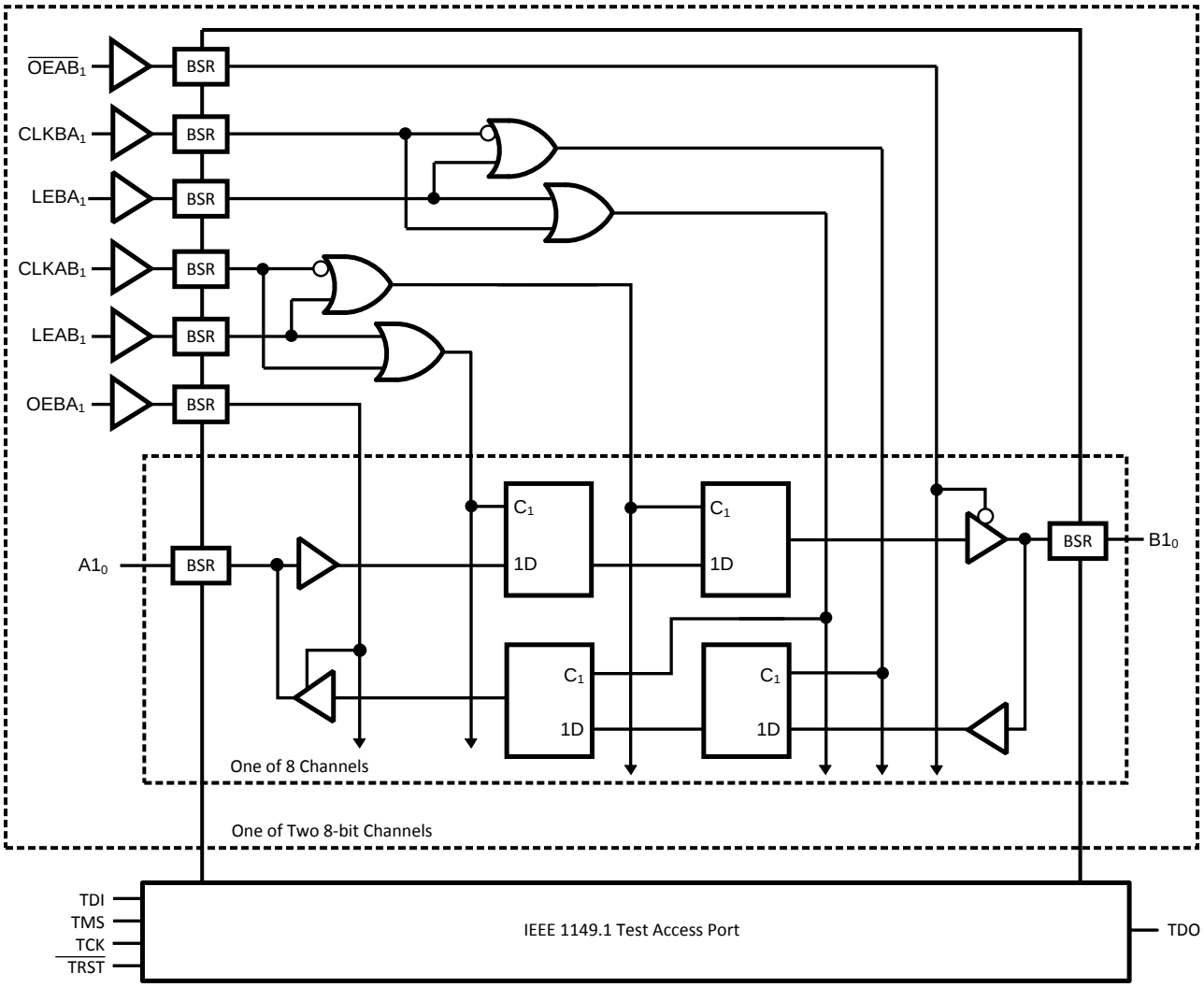
FEATURES

- **IEEE 1149.1 (JTAG) Compliant**
- **2.7V to 3.6V V_{CC} Operation**
- **TRI-STATE Outputs for Bus-Oriented Applications**
- **Dual Byte-Wide Data for Bus Applications**
- **Power Down High Impedance Inputs and Outputs**
- **Optional Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors (SCANH16602, SCANH162602 Versions)**
- **Optional 25Ω Series Resistors in Outputs to Minimize Noise and Eliminate Termination Resistors (SCAN162602, SCANH162602 Versions)**
- **Supports Live Insertion/Withdrawal**
- **Includes CLAMP and HIGHZ Instructions**
- **Extended Plastic Version Features:**
  - **Baseline Control - Single Fab & Assembly Site**
  - **Process Change Notification (PCN)**
  - **Extended Temperature: -40°C to +125°C**
  - **Initial Qual & Reliability Data**
  - **Solder Lead Finish is Standard**
  - **DMS Management Support**

DESCRIPTION

The SCAN16602 is a high speed, low-power universal bus transceiver featuring data inputs organized into two 8-bit bytes with separate output enable and latch enable control signals. The byte-wide output enable controls are complimentary to allow direction control with a single R/$\overline{W}$ line and no additional logic. This function is configurable as a D-type Latch or Flip-Flop, and can operate in transparent, latched, or clocked mode. This device is compliant with IEEE 1149.1 Standard Test Access Port and Boundary Scan Architecture with the incorporation of the defined boundary-scan test logic and test access port consisting of Test Data Input (TDI), Test Data Out (TDO), Test Mode Select (TMS), Test Clock (TCK), and Test Reset ($\overline{TRST}$).

Block Diagram



PIN DESCRIPTIONS

Pin Name	Description
$A1_0$-$A1_7$, $A2_0$-$A2_7$	Normal-function A-bus I/O ports. See Function Table for A to B Data Flow and Function Table for B to A Data Flow for normal-mode logic.
$B1_0$-$B1_7$, $B2_0$-$B2_7$	Normal-function B-bus I/O ports. See Function Table for A to B Data Flow and Function Table for B to A Data Flow for normal-mode logic.
$CLKAB_1$, $CLKBA_1$, $CLKAB_2$, $CLKBA_2$	Normal-function clock inputs. See Function Table for A to B Data Flow and Function Table for B to A Data Flow for normal-mode logic.
GND	Ground
V_{CC}	Supply Voltage
$LEAB_1$, $LEBA_1$, $LEAB_2$, $LEBA_2$	Normal-function latch enables. See Function Table for A to B Data Flow and Function Table for B to A Data Flow for normal-mode logic.
$\overline{OEAB}_1$, $\overline{OEBA}_1$, $\overline{OEAB}_2$, $\overline{OEBA}_2$	Normal-function output enables. See Function Table for A to B Data Flow and Function Table for B to A Data Flow for normal-mode logic.
TDO	The Test Data Output to support IEEE Std 1149.1-1990. TDO is the serial output for shifting data through the instruction register or selected data register.
TMS	The Test Mode Select input to support IEEE Std 1149.1-1990. TMS directs the device through it's TAP controller states. An internal pull-up forces TMS high if left unconnected.
TCK	The Test Clock input to support IEEE Std 1149.1-1990. Test operations of the device are synchronous to TCK. Data is captured on the rising edge of TCK and outputs change on the falling edge of TCK.
TDI	The Test Data Input to support IEEE Std 1149.1-1990. TDI is the serial input to shift data through the instruction register or the selected data register. An internal pull-up resistor forces TDI high if left unconnected.
$\overline{TRST}$	The Test Reset Input to support IEEE Std 1149.1-1990. TRST is the asynchronous reset pin which will force the TAP controller to it's initialization state when active. An internal pullup resistor forces $\overline{TRST}$ high if left unconnected.

BGA Pinout

	1	2	3	4	5	6	7	8
A	$A1_0$	$A1_2$	$A1_4$	$A1_6$	$A2_0$	$A2_2$	$A2_4$	$A2_6$
B	$A1_1$	$A1_3$	$A1_5$	$A1_7$	$A2_1$	$A2_3$	$A2_5$	$A2_7$
C	$\overline{TRST}$	$CLKAB_1$	$LEAB_1$	$\overline{OEAB}_1$	GND	$CLKAB_2$	$LEAB_2$	$\overline{OEAB}_2$
D	TMS	GND	V_{CC}	GND	V_{CC}	GND	TDI	TDO
E	TCK	GND	V_{CC}	V_{CC}	GND	GND	N/C	V_{CC}
F	$CLKBA_1$	$LEBA_1$	$OEBA_1$	GND	N/C	$CLKBA_2$	$LEBA_2$	$OEBA_2$
G	$B1_1$	$B1_3$	$B1_5$	$B1_7$	$B2_1$	$B2_3$	$B2_5$	$B2_7$
H	$B1_0$	$B1_2$	$B1_4$	$B1_6$	$B2_0$	$B2_2$	$B2_4$	$B2_6$

Connection Diagram

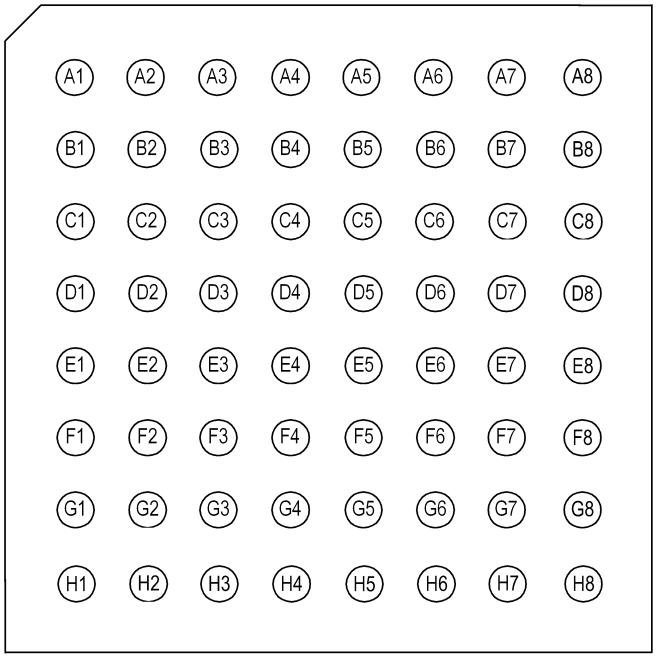


Figure 1. Top View

Function Table for A to B Data Flow(1)

Inputs				Outputs
$\overline{OEAB}$	LEAB	CLKAB	A	B
L	L	L	X	B_0(2)
L	L	↑	L	L
L	L	↑	H	H
L	H	X	L	L
L	H	X	H	H
H	X	X	X	Z

(1) H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial (HIGH or LOW, inputs may not float)
Z = High Impedance

(2) Output level before the indicated steady-state input conditions were established.

Function Table for B to A Data Flow(1)

Inputs				Outputs
OEBA	LEBA	CLKBA	B	A
H	L	L	X	A_0(2)
H	L	↑	L	L
H	L	↑	H	H
H	H	X	L	L
H	H	X	H	H
L	X	X	X	Z

(1) H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial (HIGH or LOW, inputs may not float)
Z = High Impedance

(2) Output level before the indicated steady-state input conditions were established.

Functional Description

In the normal mode, these devices are 16-bit universal bus transceivers that combine D-type latches and D-type flip-flops to allow data flow in transparent, latched, or clocked modes. They can be used as two 8-bit transceivers, or as one 16-bit transceiver. The test circuitry can be activated by the TAP to take snapshot samples of the data appearing at the device pins or to perform a self test on the boundary-test cells. Activating the TAP may affect the normal functional operation of the universal bus transceivers. When the TAP is activated, the test circuitry performs boundary-scan test operations according to the protocol described in IEEE Std 1149.1-1990.

Data flow in each direction is controlled by output-enable ($\overline{OEAB}$ and OEBA), latch-enable (LEAB and LEBA), and clock (CLKAB and CLKBA) inputs. For A-to-B data flow, the devices operate in the transparent mode when LEAB is high. When LEAB is low, the A data is latched while CLKAB is held at a static low or high logic level. Otherwise, if LEAB is low, A data is stored on a low-to-high transition of CLKAB. When $\overline{OEAB}$ is LOW, the B outputs are active. When $\overline{OEAB}$ is HIGH, the B outputs are in the high-impedance state. B-to-A data flow is similar to A-to-B data flow but uses the OEBA, LEBA, and CLKBA inputs. The output enables are complimentary to facilitate the use of a single R/$\overline{W}$ signal without additional logic.

Five dedicated test pins are used to observe and control the operation of the test circuitry: test data input (TDI), test data output (TDO), test mode select (TMS), test clock (TCK), and test reset ($\overline{TRST}$). All testing and scan operations are synchronized to the TAP interface.

For details about the sequence of boundary scan cells in the SCAN16602, please refer to the BSDL (Boundary Scan Description Language) file available on our website at http://www.ti.com/lsds/ti/analog/interface.page.

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings(1)

Supply Voltage (V_{CC})		−0.5V to +4.6V
DC Input Diode Current (I_{IK})	V_I = −0.5V	−50 mA
DC Output Diode Current (I_{OK})	V_O = −0.5V	−50 mA
DC Input Voltage (V_I)		−0.5V to 4.6V
DC Output Voltage (V_O)		−0.5V to 4.6V
DC Output Source/Sink Current (I_O)		±50 mA
DC V_{CC} or Ground Current per Supply Pin		±100 mA
Junction Temperature		+150°C
Storage Temperature		−65°C to +150°C
Lead Temperature (Solder, 4sec)	64L BGA	220 °C
Thermal Resistance	BGA θ_{JA}	62°C/W
Package Derating		16.1mW/°C above 25°C
ESD (Min)		2000V

(1) Absolute maximum ratings are those values beyond which damage to the device may occur.

Recommended Operating Conditions

Supply Voltage (V_{CC})	SCAN16602	2.7V to 3.6V
Input Voltage (V_I)		0V to 3.6V
Output Voltage (V_O)		0V to 3.6V
Operating Temperature (T_A)	Industrial	−40°C to +85°C
	Extended Plastic	−40°C to +125°C

DC Electrical Characteristics

Symbol	Parameter	V_{CC} (V)	Industrial T_A = −40°C to +85°C		Extended Plastic T_A = −40°C to +125°C		Units	Conditions
			Min	Max	Min	Max		
V_{IH}	Minimum High Input Voltage	2.7 3.6	2.0 2.0				V	V_{OUT} = 0.1V or V_{CC} −0.1V
V_{IL}	Maximum Low Input Voltage	2.7 3.6		0.8 0.8			V	V_{OUT} = 0.1V or V_{CC} −0.1V
V_{OH}	Minimum High Output Voltage All Outputs, All Options	2.7 3.6	2.5 3.4				V	I_{OUT} = −100 µA
	Minimum High Output Voltage TDO Outputs, All Options	2.7	2.2				V	V_{IN} = V_{IL} or V_{IH}, I_{OH} = −12mA
		3.0	2.2				V	V_{IN} = V_{IL} or V_{IH} I_{OH} = −24mA
	Minimum High Output Voltage A and B Ports: SCAN16602 and SCANH16602 options	2.7	2.2				V	V_{IN} = V_{IL} or V_{IH} I_{OH} = −12mA
		3.0	2.2				V	V_{IN} = V_{IL} or V_{IH} I_{OH} = −24mA
	Minimum High Output Voltage A and B Ports: SCAN162602 and SCANH162602 options (25Ω series resistor options)	2.7	2.2				V	V_{IN} = V_{IL} or V_{IH} I_{OH} = −4mA
		3.0	2.2				V	V_{IN} = V_{IL} or V_{IH} I_{OH} = −12mA

DC Electrical Characteristics (continued)

Symbol	Parameter	V_{CC} (V)	Industrial T_A = −40°C to +85°C		Extended Plastic T_A = −40°C to +125°C		Units	Conditions
			Min	Max	Min	Max		
V_{OL}	Maximum Low Output Voltage All Outputs, All Options	2.7		0.2			V	I_{OUT} = 100 µA
		3.6		0.2				
	Maximum Low Output Voltage TDO Outputs, All Options	2.7		0.4			V	$V_{IN} = V_{IL}$ or V_{IH}, I_{OL} = 12mA
		3.0		0.55			V	$V_{IN} = V_{IL}$ or V_{IH}, I_{OL} = 24mA
	Maximum Low Output Voltage A and B Ports: SCAN16602 and SCANH16602 Options	2.7		0.4			V	$V_{IN} = V_{IL}$ or V_{IH}, I_{OL} = 12mA
		3.0		0.55			V	$V_{IN} = V_{IL}$ or V_{IH}, I_{OL} = 24mA
	Maximum Low Output Voltage A and B Ports: SCAN162602 and SCANH162602 Options (25Ω series resistor options)	2.7		0.4			V	$V_{IN} = V_{IL}$ or V_{IH}, I_{OL} = 4mA
		3.0		0.6			V	$V_{IN} = V_{IL}$ or V_{IH}, I_{OL} = 12mA
I_{IN}	Maximum Input Leakage Current	3.6		±5.0			µA	$V_I = V_{CC}$, GND
I_{ILR}	Input Low Current	3.6	−20	−250			µA	V_{IN} = GND
I_{OZ}	Maximum I/O Leakage Current	3.6		±10.0			µA	V_I (OE) = V_{IL}, V_{IH} $V_I = V_{CC}$, GND $V_O = V_{CC}$, GND
$I_{I(HOLD)}$	Bus Hold Input Minimum Drive Hold Current(1)	2.7	±35				µA	V_I = 0.8V or 2.0V
		3.6		±500				V_I = 0 to 3.6V
V_{IKL}	Input Clamp Diode Voltage	2.7		−1.5			V	I_{IN} = −18mA
I_{OFF}	Power-off Leakage Current	0.0		±10.0			µA	$V_O = V_{CC}$, GND
I_{CC}	Maximum Quiescent Supply Current	3.6		20			µA	
I_{CCt}	Maximum I_{CC} Per Input	3.6		0.5			mA	$V_I = V_{CC}$–0.6V

(1) Applies to devices with Bus Hold feature only.

Noise Specifications

Applies to SCAN16602 and SCANH16602 options, C_L = 30pF, R_L = 500Ω to GND

Symbol	Parameter	V_{CC} (V)	Industrial T_A = 25°C Typical Limits	Extended Plastic T_A = 25°C	Units
V_{OLP}	Quiet Output Maximum Dynamic VOL(1)	3.3	1.2		V
V_{OLV}	Quiet Output Minimum Dynamic VOL(1)	3.3	-1.5		V
V_{OHP}	Quiet Output Maximum Dynamic VOH(2)	3.3	VOH + 0.9		V
V_{OHV}	Quiet Output Minimum Dynamic VOH(2)	3.3	VOH - 1.5		V

(1) Maximum number of outputs is defined as n. (n-1) outputs are switched LOW while the quiet output is monitored in a LOW (VOL) state. Also, (n-1) outputs are switched HIGH while the quiet output is monitored in a LOW (VOL) state.
(2) Maximum number of outputs is defined as n. (n-1) outputs are switched LOW while the quiet output is monitored in a HIGH (VOH) state. Also, (n-1) outputs are switched HIGH while the quiet output is monitored in a HIGH (VOH) state.

Noise Specifications

Applies to SCAN162602 and SCANH162602 options, C_L = 30pF, R_L = 500Ω to GND

Symbol	Parameter	V_{CC} (V)	Industrial	Extended Plastic	Units
			T_A = 25°C	T_A = 25°C	
			Typical Limits		
V_{OLP}	Quiet Output Maximum Dynamic VOL(1)	3.3	0.5		V
V_{OLV}	Quiet Output Minimum Dynamic VOL(1)	3.3	-0.4		V
V_{OHP}	Quiet Output Maximum Dynamic VOH(2)	3.3	VOH + 0.5		V
V_{OHV}	Quiet Output Minimum Dynamic VOH(2)	3.3	VOH - 0.5		V

(1) Maximum number of outputs is defined as n. (n-1) outputs are switched LOW while the quiet output is monitored in a LOW (VOL) state. Also, (n-1) outputs are switched HIGH while the quiet output is monitored in a LOW (VOL) state.
(2) Maximum number of outputs is defined as n. (n-1) outputs are switched LOW while the quiet output is monitored in a HIGH (VOH) state. Also, (n-1) outputs are switched HIGH while the quiet output is monitored in a HIGH (VOH) state.

AC Electrical Characteristics

Normal Operation, over recommended operating supply voltage and temperature ranges unless otherwise specified.

SCAN16602, SCANH16602					
Symbol	Parameter	Industrial		Extended Plastic	Units
		T_A = −40°C to +85°C C_L = 30pF R_L = 500Ω to GND		T_A = −40°C to +125°C C_L = 30pF R_L = 500Ω to GND	
		Min	Max		
t_{PLH}, t_{PHL}	Propagation Delay A to B, B to A		5.5 5.5		ns
t_{PLH}, t_{PHL}	Propagation Delay CLKAB to B, CLKBA to A		6.0 6.0		ns
t_{PLH}, t_{PHL}	Propagation Delay LEAB to B, LEBA to A		6.0 6.0		ns
t_{PLZ}, t_{PHZ}	Disable Time, $\overline{OEAB}$ to B, OEBA to A		7.5 7.5		ns
t_{PZL}, t_{PZH}	Enable Time, $\overline{OEAB}$ to B, OEBA to A		7.5 7.5		ns

AC Electrical Characteristics

Normal Operation, over recommended operating supply voltage and temperature ranges unless otherwise specified.

SCAN162602						
Symbol	Parameter	Industrial		Extended Plastic		Units
		T_A = −40°C to +85°C C_L = 30pF R_L = 500Ω to GND		T_A = −40°C to +125°C C_L = 30pF R_L = 500Ω to GND		
		Min	Max	Min	Max	
t_{PLH}, t_{PHL}	Propagation Delay A to B, B to A		6.0 6.0	1		ns
t_{PLH}, t_{PHL}	Propagation Delay CLKAB to B, CLKBA to A		6.5 6.5			ns
t_{PLH}, t_{PHL}	Propagation Delay LEAB to B, LEBA to A		6.5 6.5			ns
t_{PLZ}, t_{PHZ}	Disable Time, $\overline{OEAB}$ to B, OEBA to A		8.0 8.0			ns
t_{PZL}, t_{PZH}	Enable Time, $\overline{OEAB}$ to B, OEBA to A		8.0 8.0			ns

AC Electrical Characteristics

Normal Operation, over recommended operating supply voltage and temperature ranges unless otherwise specified.

SCANH162602						
Symbol	Parameter	Industrial		Extended Plastic		Units
		T_A = −40°C to +85°C C_L = 30pF R_L = 500Ω to GND		T_A = −40°C to +125°C C_L = 30pF R_L = 500Ω to GND		
		Min	Max	Min	Max	
t_{PLH}, t_{PHL}	Propagation Delay A to B, B to A		6.0 6.0			ns
t_{PLH}, t_{PHL}	Propagation Delay CLKAB to B, CLKBA to A		6.5 6.5			ns
t_{PLH}, t_{PHL}	Propagation Delay LEAB to B, LEBA to A		6.5 6.5			ns
t_{PLZ}, t_{PHZ}	Disable Time, $\overline{OEAB}$ to B, OEBA to A		8.0 8.0			ns
t_{PZL}, t_{PZH}	Enable Time, $\overline{OEAB}$ to B, OEBA to A		8.0 8.0			ns

AC Operating Requirements

Normal Operation, over recommended operating supply voltage and temperature ranges unless otherwise specified

Symbol	Parameter	Industrial	Extended Plastic	Units
		T_A = −40°C to +85°C C_L = 30 pF, R_L = 500Ω to GND	T_A = −40°C to +125°C C_L = 30 pF, R_L = 500Ω to GND	
		Ensured Minimum	Ensured Minimum	
t_S	Setup Time, A to CLKAB or B to CLKBA	1.5		ns
t_H	Hold Time, A to CLKAB or B to CLKBA	2.0		ns
t_S	Setup Time, A to LEAB or B to LEBA	1.5		ns
t_H	Hold Time, A to LEAB or B to LEBA	2.5		ns
t_W	Pulse Width, CLKAB or CLKBA, high or low	2.0		ns
t_W	Pulse Width, LEAB or LEBA high	2.0		ns
f_{max}	Maximum CLKAB or CLKBA Clock Frequency	250		MHz

AC Operating Requirements

can Test Operation, over recommended operating supply voltage and temperature ranges unless otherwise specified

Symbol	Parameter	Industrial	Extended Plastic	Units
		T_A = −40°C to +85°C C_L = 30 pF, R_L = 500Ω to GND	T_A = −40°C to +125°C C_L = 30 pF, R_L = 500Ω to GND	
		Ensured Minimum	Ensured Minimum	
t_S	Setup Time, H or L, TMS to TCK	2.0		ns
t_H	Hold Time, H or L, TCK to TMS	1.0		ns
t_S	Setup Time, H or L, TDI to TCK	1.0		ns
t_H	Hold Time, H or L, TCK to TDI	2.0		ns
t_W	Pulse Width TCK High or Low	10		ns
t_W	Pulse Width $\overline{TRST}$, Low	2.5		ns
f_{max}	Maximum TCK Clock Frequency	25		MHz
t_{REC}	Recovery Time, $\overline{TRST}$ to TCK	2.0		ns

Capacitance and I/O Characteristics

Refer to TI's website for IBIS models at www.ti.com/lsds/ti/analog/interface.page

Table 1. Device ID Register

Ordering Code	Features	Device ID	Manufacturer & LSB
SCAN16602SM	No bus hold, no series resistor	FC30	01F
SCANH16602SM	With bus hold only	FC31	01F
SCAN162602SM	With 25Ω series resistors in outputs	FC32	01F
SCANH162602SM	With 25Ω series resistors and bus hold	FC33	01F

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