

## DESCRIPTION

The HI-8685 and HI-8686 are system components for interfacing incoming ARINC 429 signals to 16-bit parallel data using proven +5V analog/digital CMOS technology. Both products incorporate the digital logic and analog line receiver circuitry in a single device.

The receivers on the HI-8685 and the HI-8686 connect directly to the ARINC 429 Bus and translate the incoming signals to normal CMOS levels. Internal comparator levels are set just below the standard 6.5 volt minimum data threshold and just above the standard 2.5 volt maximum null threshold. The -10 version of the HI-8685 allows the incorporation of an external 10KΩ resistance in series with each ARINC input for lightning protection without affecting ARINC level detection.

Both products offer high speed 16-bit parallel bus interface, a 32-bit buffer, and error detection for word length and parity. A reset pin is also provided for power-on initialization.

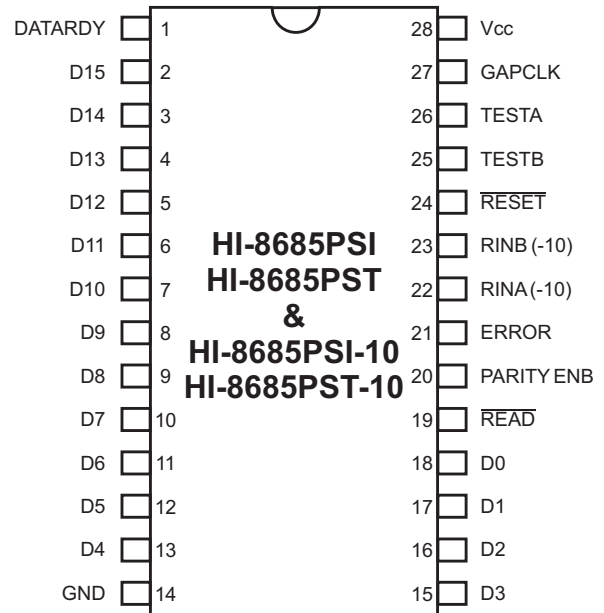
## FEATURES

- Automatic conversion of serial ARINC 429, 575 & 561 data to 16-bit parallel data
- High speed parallel 16-bit data bus
- Error detection - word length and parity
- Reset input for power-on initialization
- On-chip line receiver
- Input hysteresis of at least 2 volts
- Test inputs bypass analog inputs
- Simplified lightning protection with the ability to add 10 Kohm external series resistors
- Small, surface mount, plastic package options: SOIC, PQFP and PLCC
- Industrial and extended temperature ranges

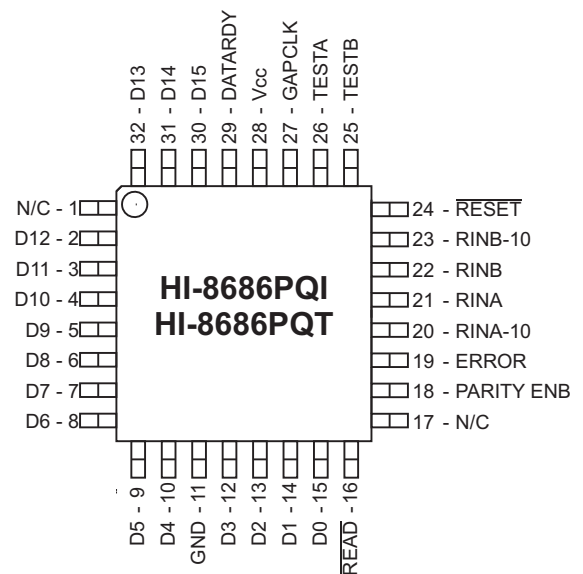
## APPLICATIONS

- Avionics data communication
- Serial to parallel conversion
- Parallel to serial conversion

## PIN CONFIGURATIONS (Top View)



**HI-8685**  
28-Pin Plastic SOIC - WB Package



**HI-8686**  
32-Pin Plastic PQFP Package

(See page 8 for additional pin configurations)

## PIN DESCRIPTIONS

SIGNAL	FUNCTION	DESCRIPTION
DATA RDY	OUTPUT	Receiver data ready flag. A high level indicates data is available in the receive buffer. Flag goes low when the first 16-bit byte is read.
D0 to D15	OUTPUT	16-bit parallel data bus (tri-state)
GND	POWER	0V
$\overline{\text{READ}}$	INPUT	Read strobe. A low level transfers receive buffer data to the data bus
PARITY ENB	INPUT	Parity Enable - A high level activates odd parity checking which replaces the 32nd ARINC bit with an error bit. Otherwise, the 32nd ARINC bit is unchanged
ERROR	OUTPUT	Error Flag. A high level indicates a bit count error (number of ARINC bits was less than or greater than 32) and/or a parity error if parity detection was enabled (PARITY ENB high)
RINA/RINA-10	INPUT	Positive direct ARINC serial data input (both RINA and RINA-10 on HI-8686)
RINB/RINB-10	INPUT	Negative direct ARINC serial data input (both RINB and RINB-10 on HI-8686)
$\overline{\text{RESET}}$	INPUT	Internal logic states are initialized with a low level
TESTA	INPUT	Used in conjunction with the TESTB input to bypass the built-in analog line receiver circuitry
TESTB	INPUT	Used in conjunction with the TESTA input to bypass the built-in analog line receiver circuitry
GAPCLK	INPUT	Gap Clock. Determines the minimum time required between ARINC words for detection. The minimum word gap time is between 16 and 17 clock cycles of this signal.
Vcc	POWER	+5V $\pm$ 5% supply

## FUNCTIONAL DESCRIPTION

The HI-8685 and HI-8686 are serial to 16-bit parallel converters. The incoming data stream is serially shifted into an input register, checked for errors, and then transferred in parallel to a 32-bit receive buffer. The receive data can be accessed using two 16-bit parallel read operations while the next serial data stream is being received.

### RECEIVER INPUTS

The block diagram for both the HI-8685 and HI-8685-10 products is found in Figure 1. Both have built-in receivers eliminating the need for additional external ARINC level detection circuitry. The only difference between the two products is the amount of internal resistance in series with each ARINC input.

#### HI-8685 ARINC INPUTS (RINA & RINB)

Internal 35K $\Omega$  resistors are in series with both the RINA and RINB ARINC 429 inputs. They connect to level translators whose resistance to GND is typically 10K $\Omega$ . After level

translation, the buffered inputs drive a differential amplifier. The differential signal is compared to levels derived from a divider between VCC and GND. The nominal settings correspond to a One/Zero amplitude of 6.0V and a Null amplitude of 3.3V. A valid ARINC One/Zero input sets a latch and a Null input resets the latch.

#### HI-8685-10 ARINC INPUTS (RINA-10 & RINB-10)

Since any added external series resistance will affect the voltage translation, the HI-8685-10 product has only 25K $\Omega$  of the 35K $\Omega$  series resistance required for proper ARINC 429 level detection. The remaining 10K $\Omega$  required is available to the user for incorporation in external circuitry such as for lightning protection.

#### HI-8686 ARINC INPUTS

The HI-8686 has both sets of ARINC inputs, RINA/RINA-10 and RINB/RINB-10 available to the user.

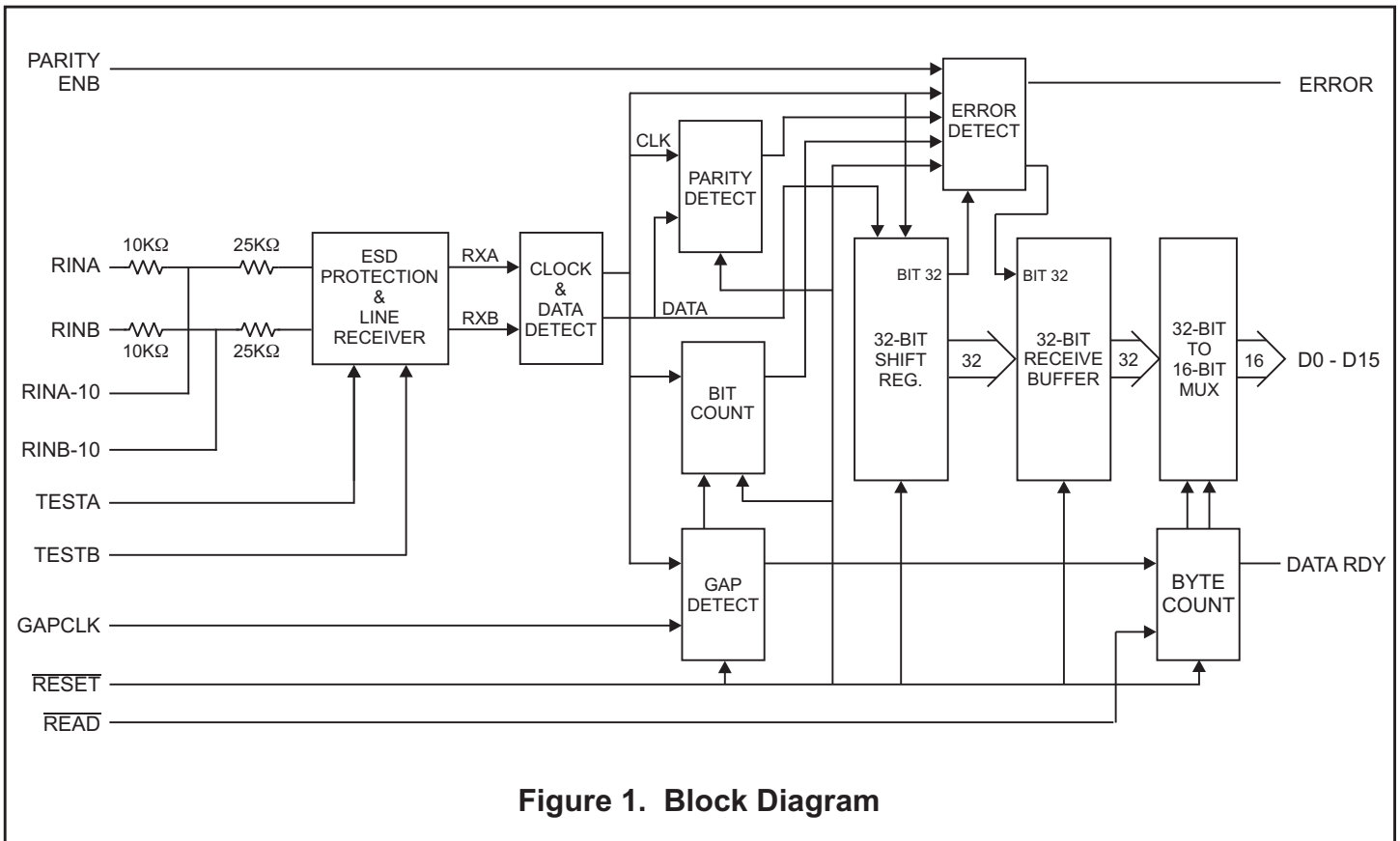


Figure 1. Block Diagram

## FUNCTIONAL DESCRIPTION (cont.)

### PROTOCOL DETECTION

The ARINC clock and One/Zero data that are derived from the digital outputs of the built-in line receiver is illustrated in Figure 3. The resulting stream of digital data is shifted into a 32-bit input register.

The ARINC clock and One/Zero data can also be created from the TESTA and TESTB inputs as shown in Figure 4. When either test input is high, the built-in analog line driver is disabled.

For ARINC 561 operation, the TESTA and TESTB digital input data streams must be derived from the ARINC 561 data, clock and sync with external logic.

### GAP DETECTION

The end of a data word is detected by an internal counter that times out when a data One or Zero is not received for a period equal to 16 cycles of the GAPCLK signal. The gap detection time may vary between 16 and 17 cycles of the GAPCLK signal since the incoming data and GAPCLK are not usually synchronous inputs. The required frequency of GAPCLK is a function of the minimum gap time specified for the type of ARINC data being received. Table 1 indicates typical frequencies that may be used for the various data rates normally encountered.

DATABUS TYPE	BIT PERIOD (μs)	MINIMUM GAP (μs)	GAP CLOCK MHz	GAP DETECTION TIME (μs)
429	10	45	0.75	21.3 - 22.7
			1.0	16 - 17
			1.5	10.7 - 11.3
429	69 - 133	310 - 599	0.1	160 - 170
575	69 - 133	310 - 599	0.1	160 - 170
561	69 - 133	103 - 200	0.2	80 - 85

Table 1 - Typical Gap Detection Times

## FUNCTIONAL DESCRIPTION (cont.)

### ERROR CHECKING

Once a word gap is detected, the data word in the input register is transferred to the receive buffer and checked for errors.

When parity detection is enabled (PARITY ENB high), the received word is checked for odd parity. If there is a parity error, the 32nd bit of the received data word is set high.

If parity checking is disabled (PARITY ENB low) the 32nd bit of the data word is always the 32nd ARINC bit received.

The ERROR flag output is set high upon receipt of a word gap and the number of bits received since the previous word gap is less than or greater than 32. The ERROR flag is reset low when the next valid ARINC word is written into the receive buffer or when  $\overline{\text{RESET}}$  is pulsed low.

### READING RECEIVE BUFFER

When the data word is transferred to the receive buffer, the DATA RDY pin goes high. The data word can then be read in two 16-bit bytes by pulsing the  $\overline{\text{READ}}$  input low as indicated in Figure 5. The first read cycle resets DATARDY low and increments an internal counter to the second 16-bit byte. The relationship between each bit of an ARINC word received and each bit of the two 16-bit data bus bytes is specified in Figure 2.

When a new ARINC word is received it always overwrites the receive buffer. If the first byte of the previous word has not been read, then previous data is lost and the receive buffer will contain the new ARINC word. However, if the DATARDY pin goes high between the reading of the first and second bytes, the first byte is no longer valid because the corresponding second byte has been overwritten by the new ARINC word. Also, the next read will be of the first byte of the new ARINC word since the internal byte counter is always reset to the first byte when new data is transferred to the receive buffer.

Read	Byte	Data Bus Bits	ARINC Bits
1st	Byte 1	D0 - D15	ARINC 1 - ARINC 16
2nd	Byte 2	D0 - D15	ARINC 17 - ARINC 32

FIGURE 2. ORDER OF RECEIVED DATA

### RESET

A low on the  $\overline{\text{RESET}}$  input sets a flip-flop which initializes the internal logic. When  $\overline{\text{RESET}}$  goes high, the internal logic remains in the initialized state until the first word gap is detected preventing reception of a partial word.

### TEST MODE

The built-in differential line receiver can be disabled allowing the data and clock detection circuitry to be driven directly with digital signals. The logical OR function of the TESTA and TESTB is defined in Truth Table 1. The two inputs can be used for testing the receiver logic and for inputting ARINC 429 type data derived from another source / protocol. See Figure 4 for typical test input timing.

The device should always be initialized with  $\overline{\text{RESET}}$  immediately after entering the test mode to clear a partial word that may have been received since the last word gap. Otherwise, an ERROR condition may occur and the first 32 bits of data on the test inputs may not be properly received.

Also, when entering the test mode, both TESTA and TESTB should be set high and held in that state for at least one word gap period (17 gap clocks) after  $\overline{\text{RESET}}$  goes high.

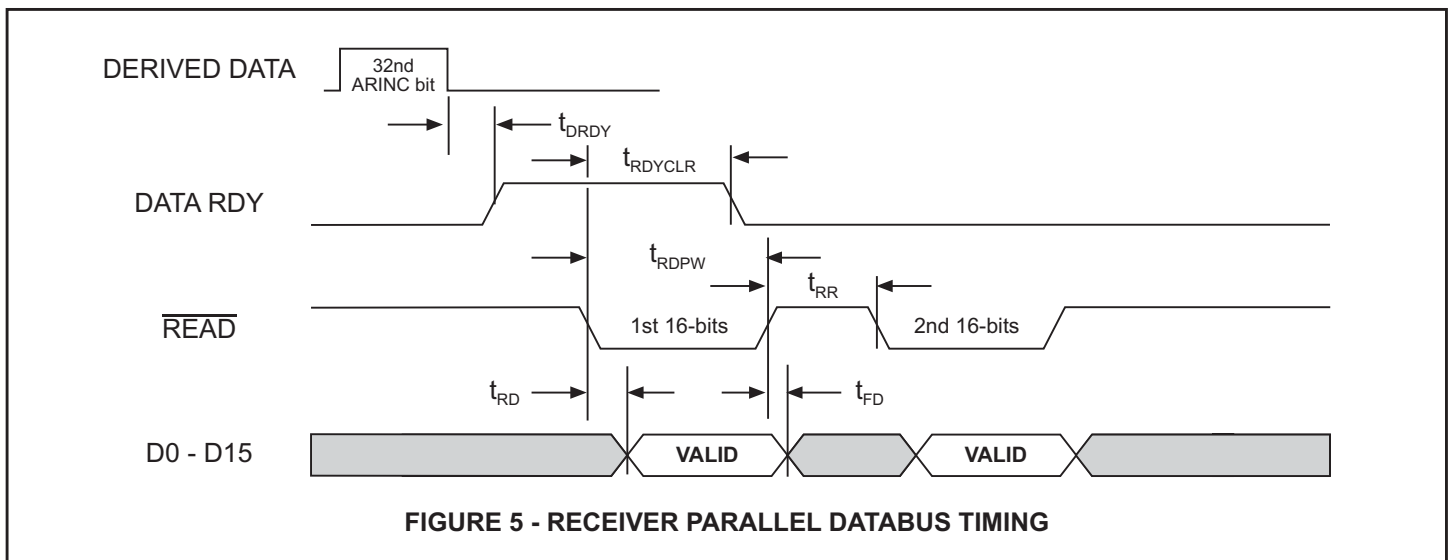
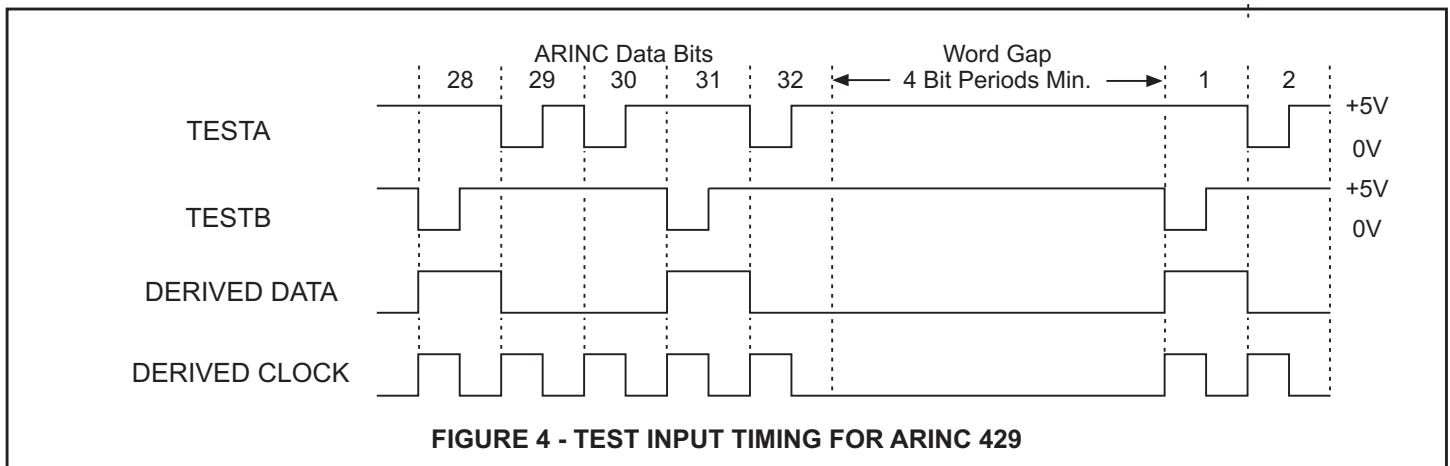
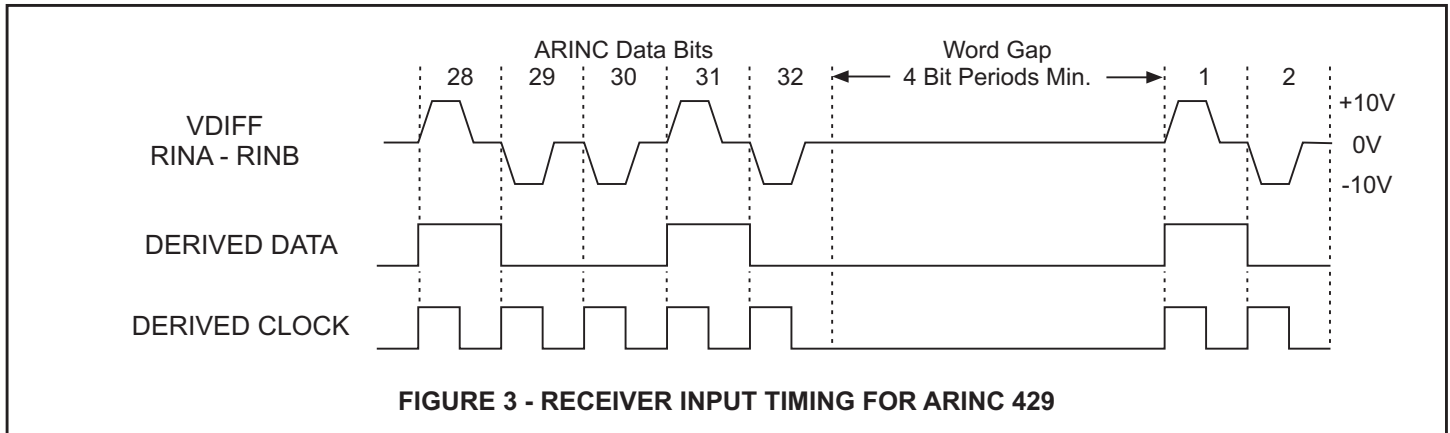
When exiting the test mode, both test inputs should be held low and the device initialized with  $\overline{\text{RESET}}$ .

TRUTH TABLE 1.

RINA (-10)	RINB (-10)	TESTA	TESTB	RXA	RXB
-1.50V to +1.50V	-1.50V to +1.50V	0	0	0	0
-3.25V to -6.50V	+3.25V to +6.50V	0	0	0	1
+3.25V to +6.50V	-3.25V to -6.50V	0	0	1	0
X	X	0	1	0	1
X	X	1	0	1	0
X	X	1	1	0	0

X = don't care

**TIMING DIAGRAMS**



**ABSOLUTE MAXIMUM RATINGS**

All voltages referenced to GND

Supply voltages Vcc ..... +7.0V
Voltage on inputs RINA (-10) to RINB (-10) ..... +29V to - 29V All other input pins.....-0.3 to Vcc +0.3
DC current per input pin ..... +10mA
Power dissipation at 25°C plastic 28-pin SO..... 1.8W, derate 14.1mW/°C plastic 28-pin PLCC .2.3W, derate 18.2mW/°C plastic 32-pin SO.....1.6W, derate 15.4mW/°C
Solder Temperature Leads ..... +280°C for 10 sec Package body .....+220°C
Storage Temperature ..... -65°C to +150°C

**RECOMMENDED OPERATING CONDITIONS**

Supply Voltages Vcc.....+5V ± 5%
Temperature Range Industrial ..... -40°C to +85°C Hi-Temp ..... -55°C to +125°C
Junction Temperature, Tj ..... ≤+175°C

*NOTE: Stresses above absolute maximum ratings or outside recommended operating conditions may cause permanent damage to the device. These are stress ratings only. Operation at the limits is not recommended.*

**DC ELECTRICAL CHARACTERISTICS**

Vcc = 5V, GND = 0V, TA = Operating Temperature Range (unless otherwise specified).

PARAMETERS	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>ARINC Bus Inputs (RINA, RINB, RINA-10 &amp; RINB-10)</b>						
Differential input voltage one or zero null common mode	V <sub>DIN</sub> V <sub>NIN</sub> V <sub>COM</sub>	differential voltage " " " " with respect to GND	6.5 - -	10.0 - -	13.0 2.75 5.0	volts volts volts
Input resistance RINA (-10) to RINB(-10) RINA (-10) or RINB(-10) to GND or Vcc	R <sub>DIFF</sub> R <sub>SUP</sub>	supplies floating " " " "	30 19	75 40	- -	Kohm Kohm
Input capacitance (Guaranteed but not tested) differential to GND to Vcc	C <sub>DIFF</sub> C <sub>G</sub> C <sub>H</sub>	RINA (-10) to RINB (-10)	- - -	- - -	20 20 20	pF pF pF
<b>Digital Inputs (<math>\overline{\text{RESET}}</math>, GAPCLK, <math>\overline{\text{READ}}</math> &amp; PARITY ENB)</b>						
Input voltage high low	V <sub>IH</sub> V <sub>IL</sub>		2.0 0.0	- -	Vcc 0.8	volts volts
Input current source sink	I <sub>IH</sub> I <sub>IL</sub>	V <sub>IN</sub> = 5.0V V <sub>IN</sub> = 0.0V	- -1.0	- -	1.0 -	µA µA
Input capacitance	C <sub>i</sub>		-	-	8.0	pF

## DC ELECTRICAL CHARACTERISTICS (cont.)

V<sub>CC</sub> = 5V, GND = 0V, TA = Operating Temperature Range (unless otherwise specified).

PARAMETERS	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>Digital Inputs (TESTA &amp; TESTB)</b>						
Input voltage high low	V <sub>IH</sub> V <sub>IL</sub>		2.4 0.0	- -	V <sub>CC</sub> 0.8	volts volts
Input current source sink	I <sub>IH</sub> I <sub>IL</sub>	V <sub>IN</sub> = 5.0V V <sub>IN</sub> = 0.0V	- -1.0	110 -	- -	μA μA
Input capacitance	C <sub>i</sub>		-	-	8.0	pF
<b>Outputs (D0 to D15, ERROR &amp; DATA RDY)</b>						
Output voltage high low	V <sub>OH</sub> V <sub>OL</sub>	I <sub>OH</sub> = -1.0 mA I <sub>OL</sub> = 1.6 mA	2.7 -	- -	- 0.4	volts volts
Output tri-state current (D0 - D15 only)	I <sub>IH</sub> I <sub>IL</sub>	V <sub>OH</sub> = 5.0V V <sub>OL</sub> = 0.0V	- -1.0	- -	1.0 -	μA μA
Output capacitance	C <sub>o</sub>		-	-	15	pF
<b>Operating Supply Current</b>						
V <sub>CC</sub>	I <sub>CC</sub>	V <sub>IN</sub> = 0.0V, outputs open	-	-	6.5	mA

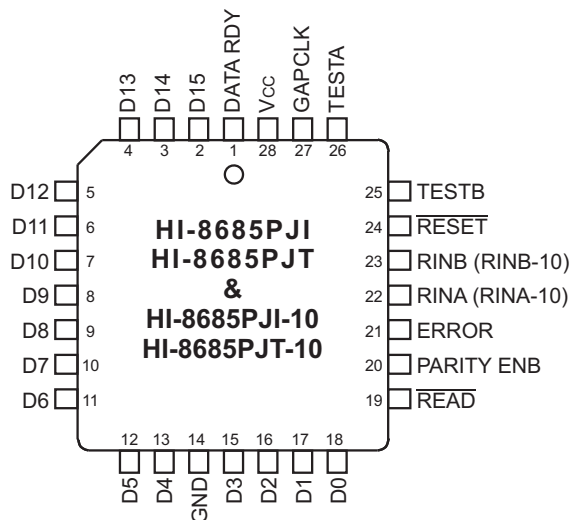
## AC ELECTRICAL CHARACTERISTICS

V<sub>CC</sub> = 5V, GND = 0V, TA = Operating Temperature Range (unless otherwise specified).

PARAMETERS	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
$\overline{\text{READ}}$ pulse width	t <sub>RDPW</sub>		50			ns
Data delay from $\overline{\text{READ}}$	t <sub>RD</sub>				40	ns
$\overline{\text{READ}}$ to data floating	t <sub>FD</sub>				20	ns
$\overline{\text{READ}}$ to DATA RDY clear	t <sub>RDYCLR</sub>				35	ns
$\overline{\text{READ}}$ pulse to next $\overline{\text{READ}}$ pulse	t <sub>RR</sub>		25			ns
GAPCLK frequency	f <sub>GC</sub>			1		MHz
32nd ARINC bit to DATA RDY	t <sub>DRDY</sub>		16		17	clocks

## ADDITIONAL HI-8685 PIN CONFIGURATION

(See page 1 for additional pin configurations)



**HI-8685**  
**28-Pin Plastic PLCC**

## ORDERING INFORMATION

HI - 8685xx x x - xx

PART NUMBER	INPUT SERIES RESISTANCE	
	BUILT-IN	REQUIRED EXTERNALLY
No dash number	35 Kohm	0
-10	25 Kohm	10 Kohm

PART NUMBER	LEAD FINISH
Blank	Tin / Lead (Sn / Pb) Solder
F	100% Matte Tin (Pb-free, RoHS compliant)

PART NUMBER	TEMPERATURE RANGE	FLOW	BURN IN
I	-40°C TO +85°C	I	No
T	-55°C TO +125°C	T	No

PART NUMBER	PACKAGE DESCRIPTION	BUILT-IN LINE RECV'R
8685PJ	28 PIN PLASTIC PLCC (28J)	Yes
8685PS	28 PIN PLASTIC WIDE SOIC (28HW)	Yes

For HI-8686PQ please see next page



**ORDERING INFORMATION**

HI - 8686PQ x x

PART NUMBER	LEAD FINISH		
Blank	Tin / Lead (Sn / Pb) Solder		
F	100% Matte Tin (Pb-free, RoHS compliant)		

PART NUMBER	TEMPERATURE RANGE	FLOW	BURN IN
I	-40°C TO +85°C	I	No
T	-55°C TO +125°C	T	No

PART NUMBER	PACKAGE DESCRIPTION	BUILT-IN LINE RECV'R	EXT. 10KΩ REQUIRED
8686PQ	32 PIN PLASTIC PQFP (32PQS)	Yes	Optional (1)

(1) RINA / RINB and RINA-10 / RINB-10 are both available

For HI-8685 please see previous page

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## REVISION HISTORY

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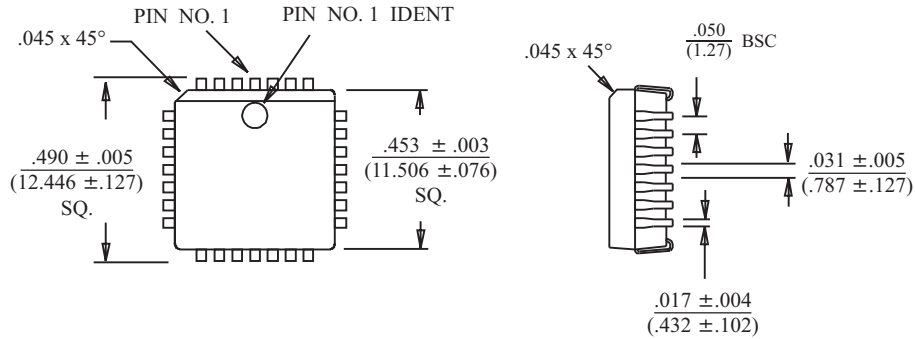
Revision	Date	Description of Change
DS8685, Rev. N	12/15/08	Replaced 18-pin SOIC Package Dimension drawing with correct 28-pin drawing, corrected dimensions for PQFP package to reflect current package vendor, and clarified temperature ranges.

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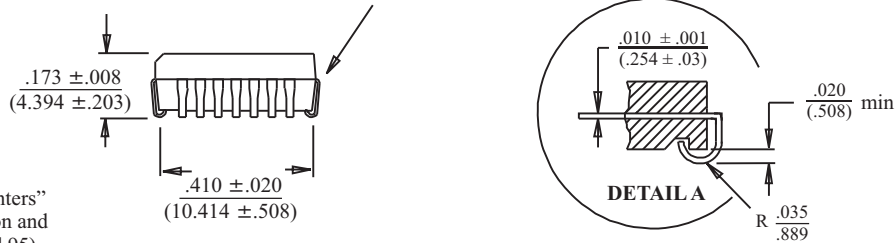
**28-PIN PLASTIC PLCC**

*inches (millimeters)*

Package Type: 28J



See Detail A

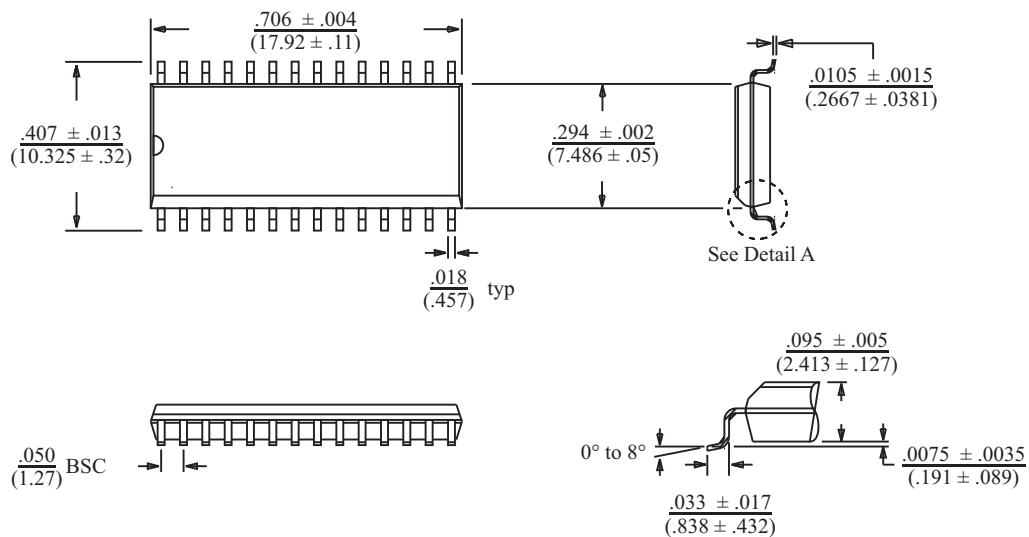


BSC = "Basic Spacing between Centers" is theoretical true position dimension and has no tolerance. (JEDEC Standard 95)

**28-PIN PLASTIC SMALL OUTLINE (SOIC) - WB  
(Wide Body)**

*inches (millimeters)*

Package Type: 28HW

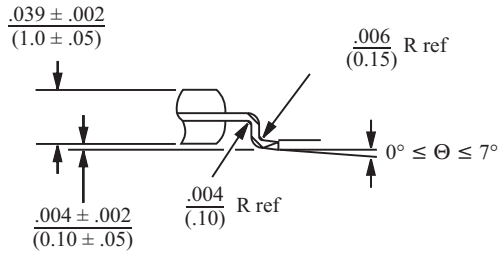
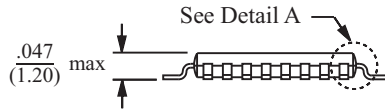
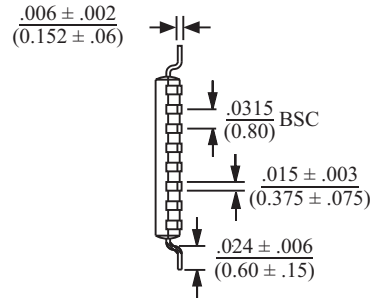
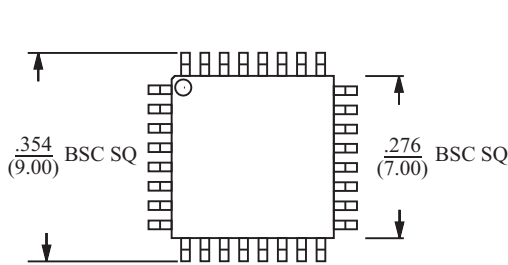


BSC = "Basic Spacing between Centers" is theoretical true position dimension and has no tolerance. (JEDEC Standard 95)

**32 PIN PLASTIC QUAD FLAT PACK (PQFP)**

*inches (millimeters)*

Package Type: 32PQS



BSC = "Basic Spacing between Centers" is theoretical true position dimension and has no tolerance. (JEDEC Standard 95)

Detail A