SY58022U

5.5 GHz, 1:4 Fanout Buffer/Translator with 400 mV LVPECL Outputs and Internal Input Termination

Features

- Precision 1:4, 400 mV LVPECL Fanout Buffer
- Ensured AC Performance over Temperature and Voltage:
  - >5.5 GHz f_{MAX} Clock
  - <80 ps t_r/t_f Times
  - <250 ps (V_{IN} ≥300 mV) t_{PD}
  - <15 ps Maximum Skew
- Low Jitter Performance: 60 fs_{RMS} Phase Jitter
- Accepts an Input Signal as Low as 100 mV
- Unique Input Termination and VT Pin Accepts DC- and AC-Coupled Differential Inputs: LVPECL, LVDS, and CML
- 400 mV LVPECL Compatible Outputs
- Power Supply: 2.5V ±5% and 3.3V ±10%
- –40°C to +85°C Temperature Range
- Available in a 16-Lead 3 mm x 3 mm VQFN Package

Applications

- All SONET and All GigE Clock Distribution
- Fibre Channel Clock and Data Distribution
- Backplane Distribution
- Data Distribution: OC-48, OC-48+FEC, XAUI
- High-End, Low-Skew, Multiprocessor Synchronous Clock Distribution

General Description

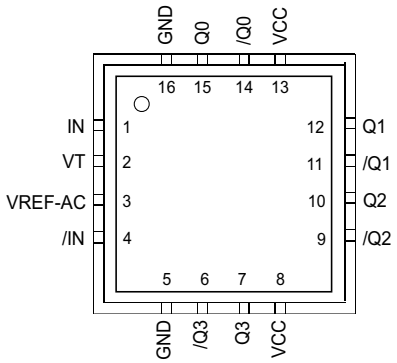
The SY58022U is a 2.5V/3.3V precision, high-speed, fully differential 1:4 LVPECL fanout buffer. Optimized to provide four identical output copies with less than 15 ps of skew and less than 10 ps_{PP} total jitter, the SY58022U can process clock signals as fast as 5.5 GHz.

The differential input includes Microchip's unique, 3-pin input termination architecture interfaces to differential LVPECL, CML, and LVDS signals (AC- or DC-coupled) as small as 100 mV without any level-shifting or termination resistor networks in the signal path. For AC-coupled input interface applications, an on-board output reference voltage (V_{REF-AC}) is provided to bias the VT pin. The outputs are 400 mV LVPECL compatible with extremely fast rise/fall times ensured to be less than 80 ps.

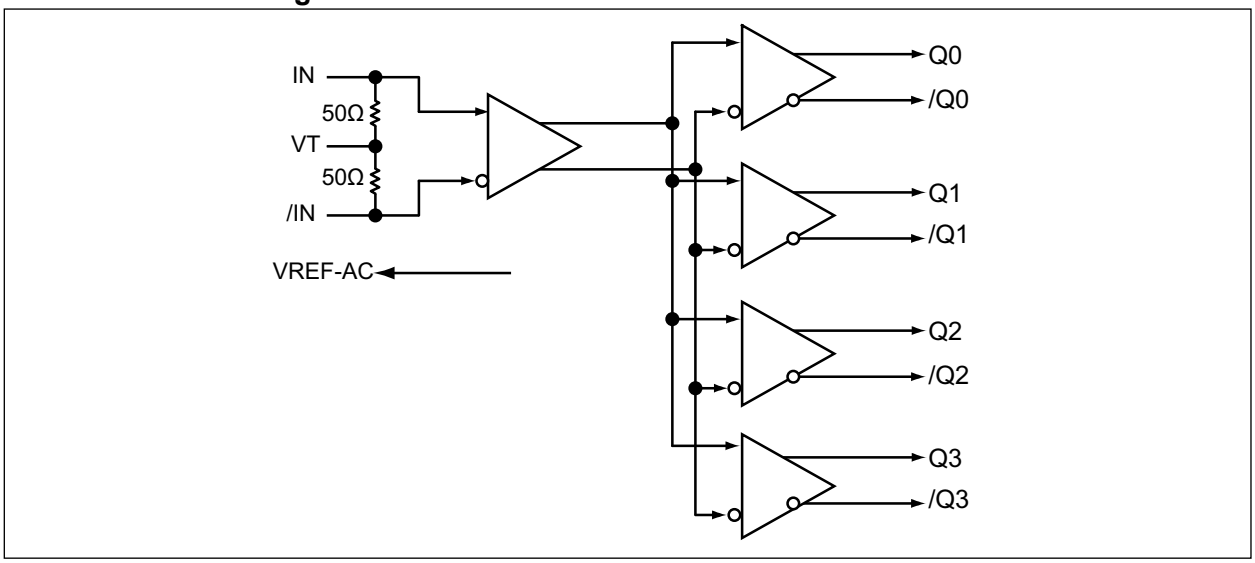
The SY58022U operates from a 2.5V ±5% supply or 3.3V ±10% supply and is ensured over the full industrial temperature range (–40°C to +85°C). For applications that require greater output swing or CML compatible outputs, consider the SY58021U 1:4 fanout buffer with LVPECL outputs, or the SY58020U 1:4 fanout buffer with 400 mV CML outputs.

Package Type

SY58022U
3 mm x 3 mm VQFN (M)
(Top View)



Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Power Supply Voltage (V_{CC}) ..... –0.5V to +4.0V
Input Voltage (V_{IN}) ..... –0.5V to V_{CC}
Continuous Output Current (I_{OUT}) ..... 50 mA
Surge Output Current (I_{OUT}) ..... 100 mA
Source or Sink Current on VT Pin ..... ±100 mA
Source or Sink Current on (IN, /IN) Pins ..... ±50 mA
Source or Sink Current on VREF-AC Pin (Note 1) ..... ±1.5 mA

Operating Ratings ††

Power Supply Voltage (V_{CC}) ..... +2.375V to +3.60V

† Notice: Permanent device damage may occur if absolute maximum ratings are exceeded. This is a stress rating only and functional operation is not implied at conditions other than those detailed in the operational sections of this data sheet. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

†† Notice: The data sheet limits are not guaranteed if the device is operated beyond the operating ratings.

Note 1: Due to the limited drive capability, use for input of the same package only.

DC ELECTRICAL CHARACTERISTICS

T_A = –40°C to +85°C. Note 1

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Power Supply Voltage	V_{CC}	2.375	2.5	2.625	V	V_{CC} = 2.5V
		3.0	3.3	3.6		V_{CC} = 3.3V
Power Supply Current	I_{CC}	—	125	160	mA	No load, V_{CC} = Max.
Input High Voltage	V_{IH}	1.2	—	V_{CC}	V	—
Input Low Voltage	V_{IL}	0	—	V_{IH} – 0.1	V	IN, /IN
Input Voltage Swing	V_{IN}	0.1	—	3.6	V	IN, /IN; See Figure 4-1
Differential Input Voltage	V_{DIFF_IN}	0.2	—	3.4	V	IN, /IN; See Figure 4-2
IN-to-VT Resistance	R_{IN}	40	50	60	Ω	—
Output Reference Voltage	V_{REF-AC}	V_{CC} – 1.3	V_{CC} – 1.2	V_{CC} – 1.1	V	—
IN-to-VT Voltage	V_{T_IN}	—	—	1.28	V	—

Note 1: The circuit is designed to meet the DC specifications shown in the table above after thermal equilibrium has been established.

LVPECL DC ELECTRICAL CHARACTERISTICS

V_{CC} = 3.3V ±10% or V_{CC} = 2.5 ±5%; R_L= 50Ω to V_{CC} – 2V; T_A = –40°C to +85°C, unless otherwise stated. Note 1

Parameter	Symbol	Min.	Typ.	Max.	Units	Condition
Output High Voltage	V_{OH}	V_{CC} – 1.145	V_{CC} – 1.020	V_{CC} – 0.895	V	—
Output Low Voltage	V_{OL}	V_{CC} – 1.545	V_{CC} – 1.420	V_{CC} – 1.295	V	—
Output Voltage Swing	V_{OUT}	150	400	650	mV	See Figure 4-1
Differential Output Swing	V_{DIFF_OUT}	300	800	1300	mV	See Figure 4-2

Note 1: The circuit is designed to meet the DC specifications shown in the table above after thermal equilibrium has been established.

AC ELECTRICAL CHARACTERISTICS

V_{CC} = 2.5V ±5% or 3.3V ±10%; R_L = 50Ω to V_{CC} – 2V; T_A = –40°C to +85°C, unless otherwise stated.

Parameter	Symbol	Min.	Typ.	Max.	Units	Condition
Maximum Operating Frequency	f_{MAX}	5.5	—	—	GHz	Clock, V_{OUT} ≥ 200 mV
		—	10	—	Gbps	NRZ Data
Propagation Delay	t_{PD}	130	200	280	ps	—
Channel-to-Channel Skew	t_{CHAN}	—	4	15	ps	Note 1
Part-to-Part Skew	t_{SKEW}	—	—	50	ps	Note 2
RMS Phase Jitter	t_{JITTER}	—	60	—	fs	Output = 622 MHz, Integration range: 12 kHz to 20 MHz
Output Rise/Fall Time	t_r/t_f	20	50	80	ps	20% to 80%, At full swing

Note 1: Skew is measured between outputs of the same bank under identical transitions.

2: Skew is defined for two parts with identical power supply voltages at the same temperature and with no skew of the edges at the respective inputs.

TEMPERATURE SPECIFICATIONS

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Operating Temperature Range	T_A	–40	—	+85	°C	—
Lead Temperature	—	—	—	+260	°C	Soldering, 20 sec.
Storage Temperature Range	T_S	–65	—	+150	°C	—
Package Thermal Resistances						
Thermal Resistance, 3x3 VQFN 16-Ld	θ_{JA}	—	60	—	°C/W	Still-air
			54			500 lpfm
	θ_{JB}	—	33	—	°C/W	Junction-to-board, Note 1

Note 1: Thermal performance assumed exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

V_{CC} = 3.3V, V_{EE} = 0V, V_{IN} = 100 mV, T_A = +25°C, unless otherwise stated.

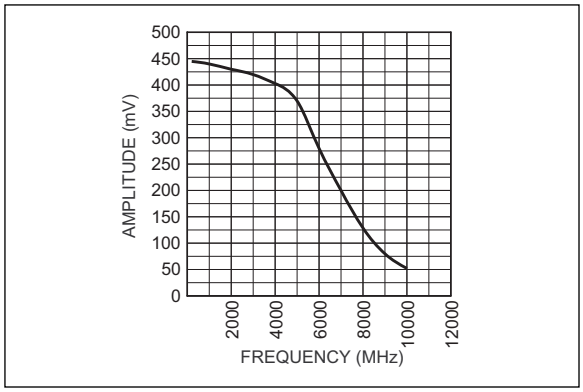


FIGURE 2-1: *Amplitude vs. Frequency.*

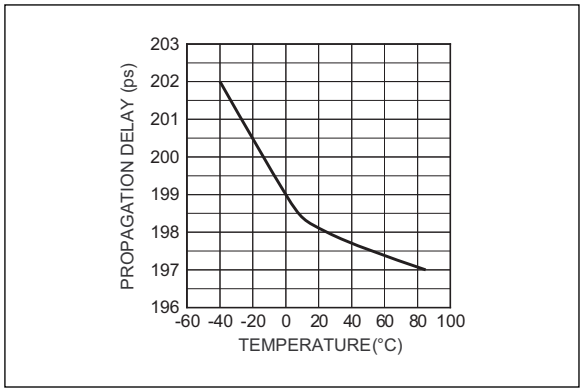


FIGURE 2-4: *Propagation Delay vs. Temperature.*

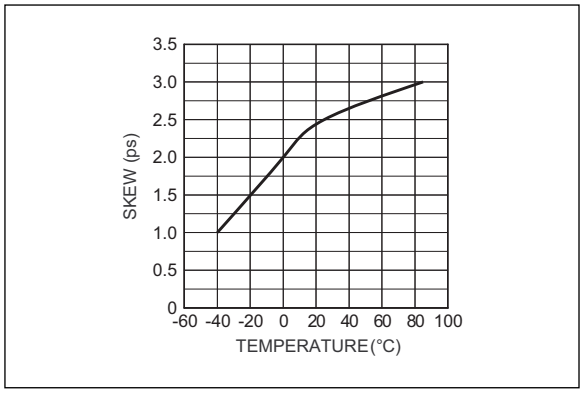


FIGURE 2-2: *Skew vs. Temperature.*

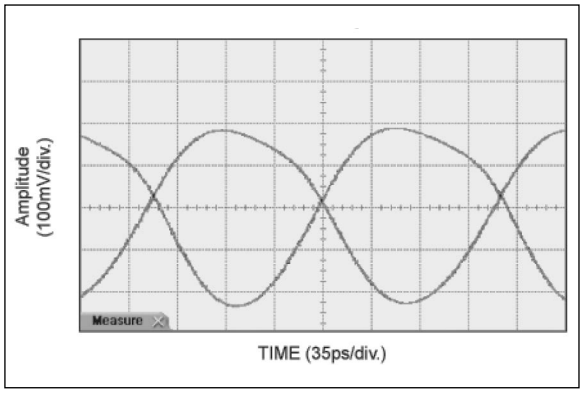


FIGURE 2-5: *4 GHz Output.*

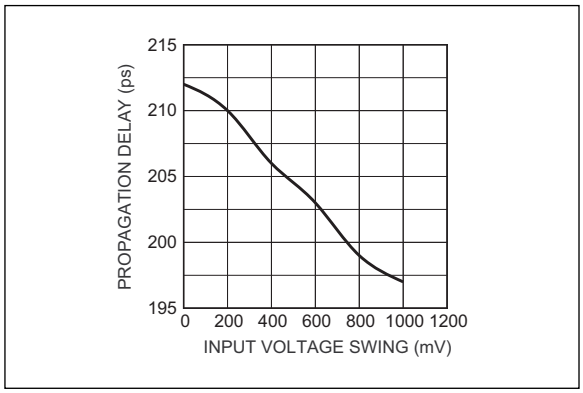


FIGURE 2-3: *Propagation Delay vs. Input Voltage Swing.*

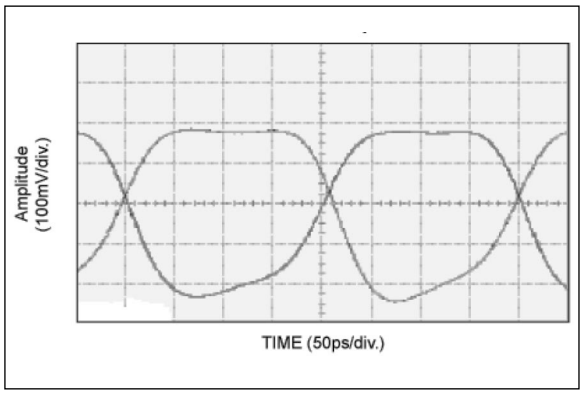


FIGURE 2-6: *2.5 GHz Output.*

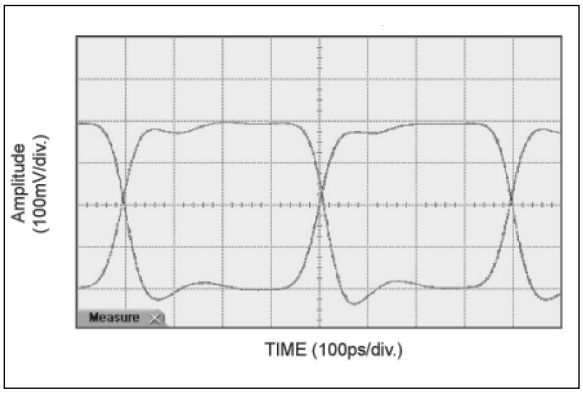


FIGURE 2-7: *1.25 GHz Output.*

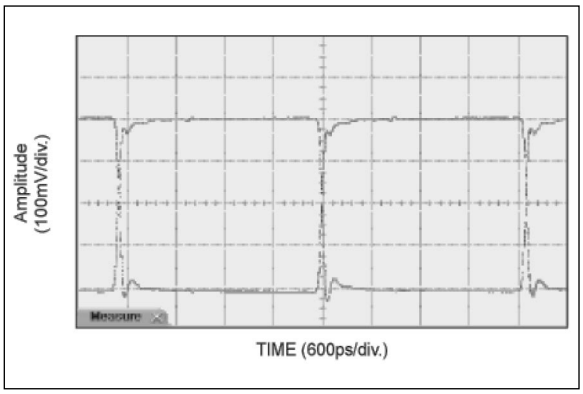


FIGURE 2-8: *200 MHz Output.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1, 4	IN, /IN	Differential Input: This input pair receives the signal to be buffered. Each pin is internally terminated with 50Ω to the VT pin. Note that this input will default to an indeterminate state if left open. See the Input Interface Applications section.
2	VT	Input Termination Center-Tap: Each input terminates to this pin. The VT pin provides a center-tap for each input (IN, /IN) to the termination network for maximum interface flexibility. See the Input Interface Applications section.
3	VREF-AC	Reference Output Voltage: This output biases to V_{CC} – 1.2V. It is used when AC-coupling to differential inputs. Connect VREF-AC directly to the VT pin. Bypass with 0.01 µF low ESR capacitor to VCC. See the Input Interface Applications section.
8, 13	VCC	Positive Power Supply: Bypass with 0.1 µF//0.01 µF low-ESR capacitors as close to the pins as possible. A 0.01 µF capacitor should be as close to the VCC pin as possible.
5, 16	GND, Exposed Pad	Ground. Exposed pad must be connected to a ground plane that is the same potential as the ground pin.
14, 15 11, 12 9, 10 6, 7	/Q0, Q0 /Q1, Q1 /Q2, Q2 /Q3, Q3	LVPECL Differential Output Pairs: Differential buffered output copy of the input signal. The output swing is typically 400 mV. Proper termination is 50Ω to V_{CC} – 2V at the receiving end. Unused output pairs may be left floating with no impact on jitter or skew. See the Output Termination Recommendations section.

4.0 SINGLE-ENDED AND DIFFERENTIAL SWINGS

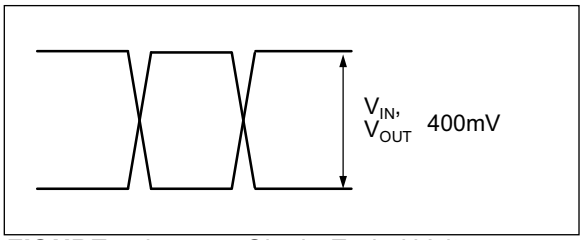


FIGURE 4-1: *Single-Ended Voltage Swing.*

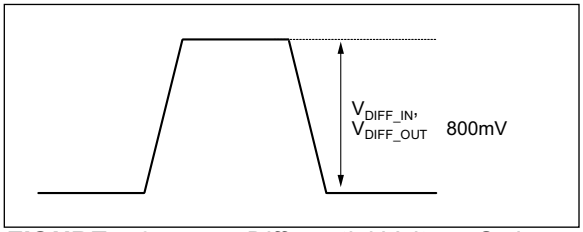


FIGURE 4-2: *Differential Voltage Swing.*

5.0 TIMING DIAGRAM

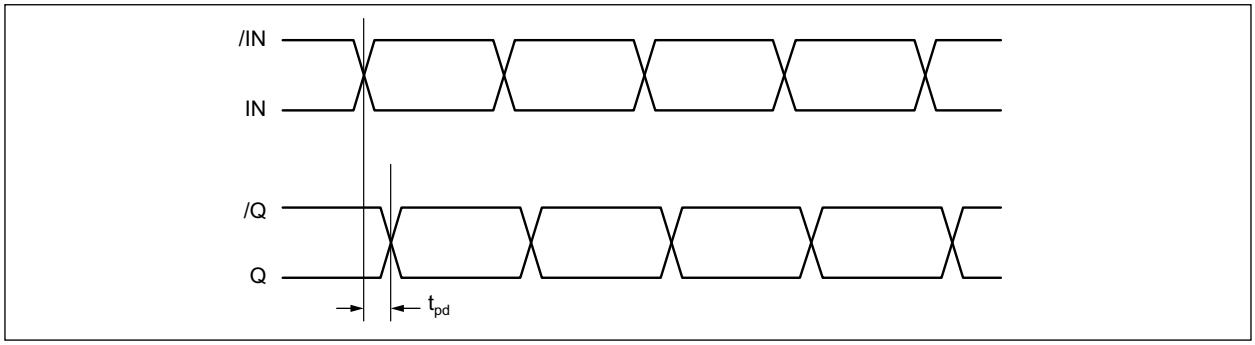


FIGURE 5-1: *Timing Diagram.*

6.0 INPUT STAGE

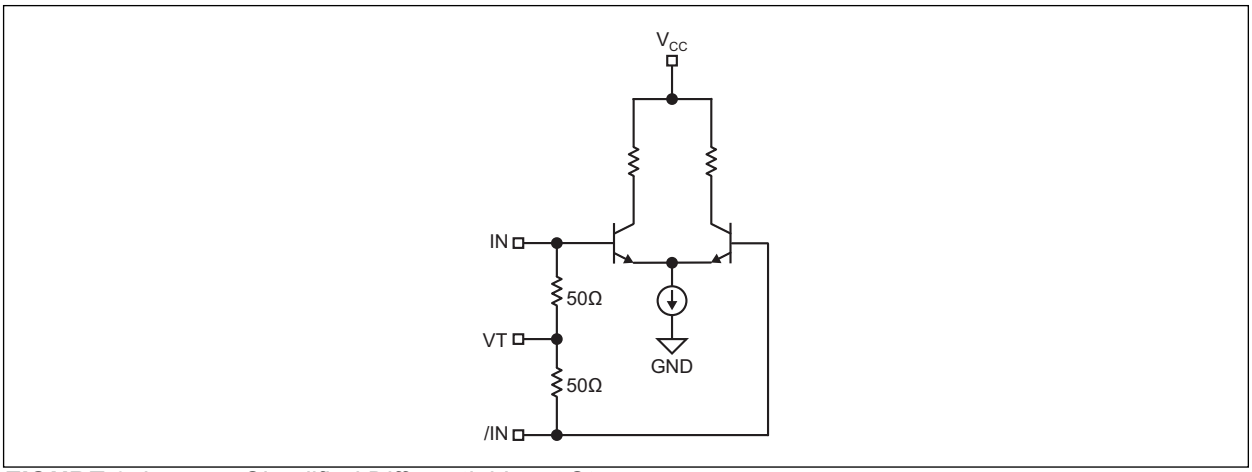


FIGURE 6-1: *Simplified Differential Input Stage.*

7.0 INPUT INTERFACE APPLICATIONS

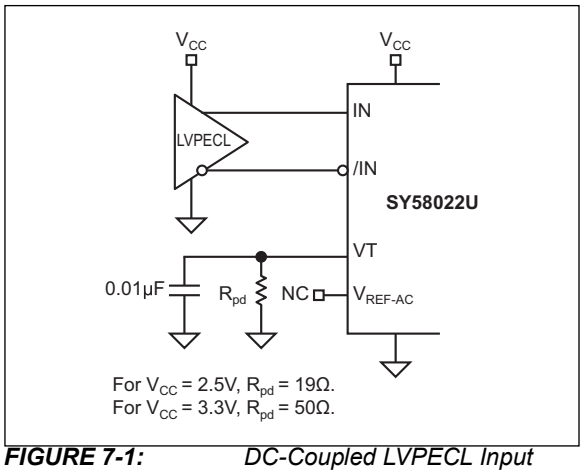


FIGURE 7-1: *DC-Coupled LVPECL Input Interface.*

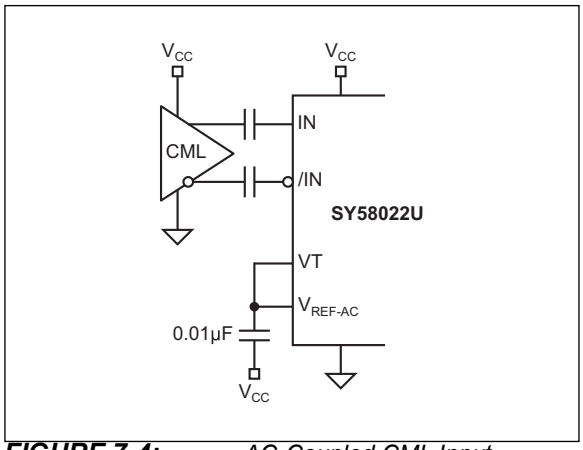


FIGURE 7-4: *AC-Coupled CML Input Interface.*

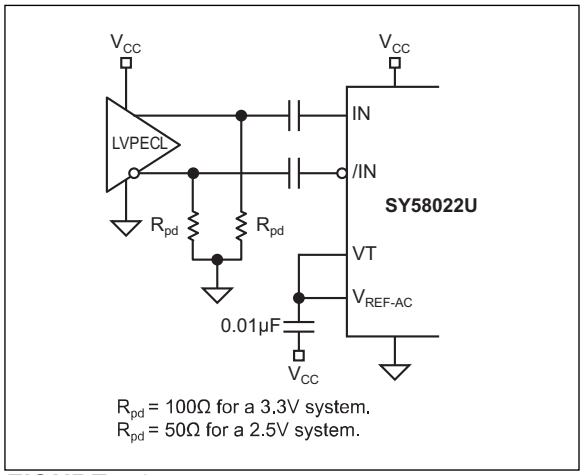


FIGURE 7-2: *AC-Coupled LVPECL Input Interface.*

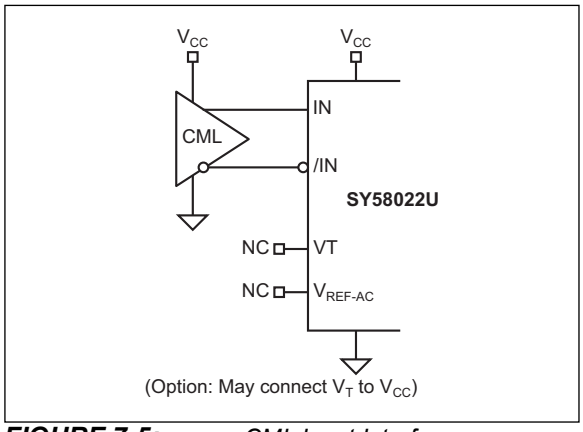


FIGURE 7-5: *CML Input Interface.*

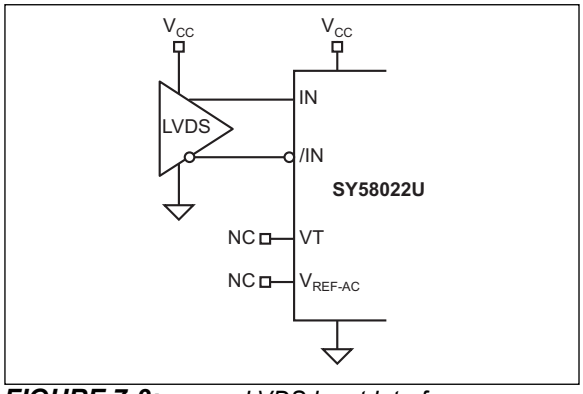


FIGURE 7-3: *LVDS Input Interface.*

8.0 OUTPUT TERMINATION RECOMMENDATIONS

LVPECL outputs have very low output impedance (open emitter), and small signal swing which results in low EMI (electro-magnetic interference). The LVPECL is ideal for driving 50Ω-controlled and 100Ω-controlled impedance transmission lines. In addition, LVPECL is compatible for driving standard PECL inputs because PECL inputs require only 100 mV input swing. Further, there are several techniques in terminating the LVPECL outputs, as shown in Figure 8-1 through Figure 8-3.

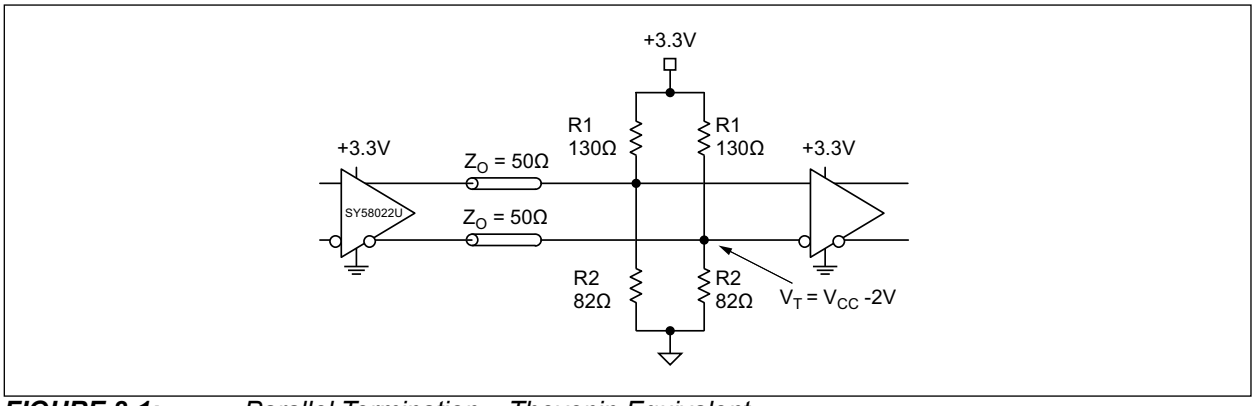


FIGURE 8-1: *Parallel Termination – Thevenin Equivalent.*

Note: For +2.5V systems: R1 = 250Ω, R2 = 62.5Ω. For +3.3V systems: R1 = 130Ω, R2 = 83Ω.

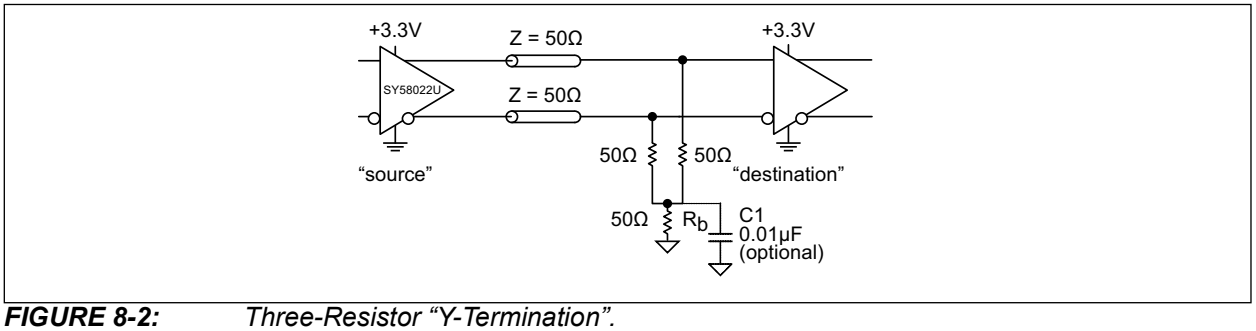


FIGURE 8-2: *Three-Resistor "Y-Termination".*

Note: Power-saving alternative to Thevenin termination. Place termination resistors as close to destination inputs as possible. R_b resistor sets the DC bias voltage, equal to V_T. For +2.5V systems, R_b = 19Ω. For 3.3V systems, R_b = 46Ω to 50Ω. C1 is an optional bypass capacitor intended to compensate for any t_r/t_f mismatches.

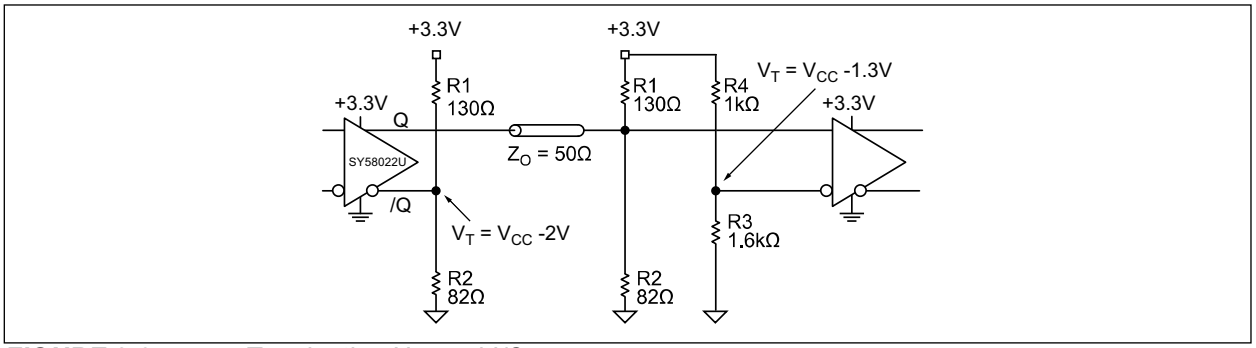


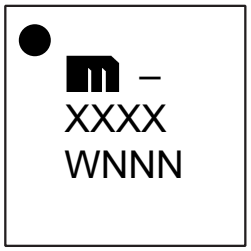
FIGURE 8-3: *Terminating Unused I/O.*

Note: Unused output (/Q) must be terminated to balance the output. For +2.5V systems: R1 = 250Ω, R2 = 62.5Ω, R3 = 1.25 kΩ, R4 = 1.2 kΩ. For +3.3V systems: R1 = 130Ω, R2 = 82Ω, R3 = 1 kΩ, R4 = 1.6 kΩ. Unused output pairs (Q and /Q) may be left floating.

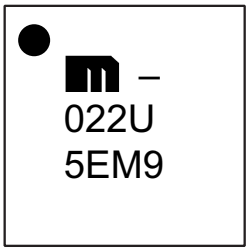
9.0 PACKAGING INFORMATION

9.1 Package Marking Information

16-Lead VQFN*



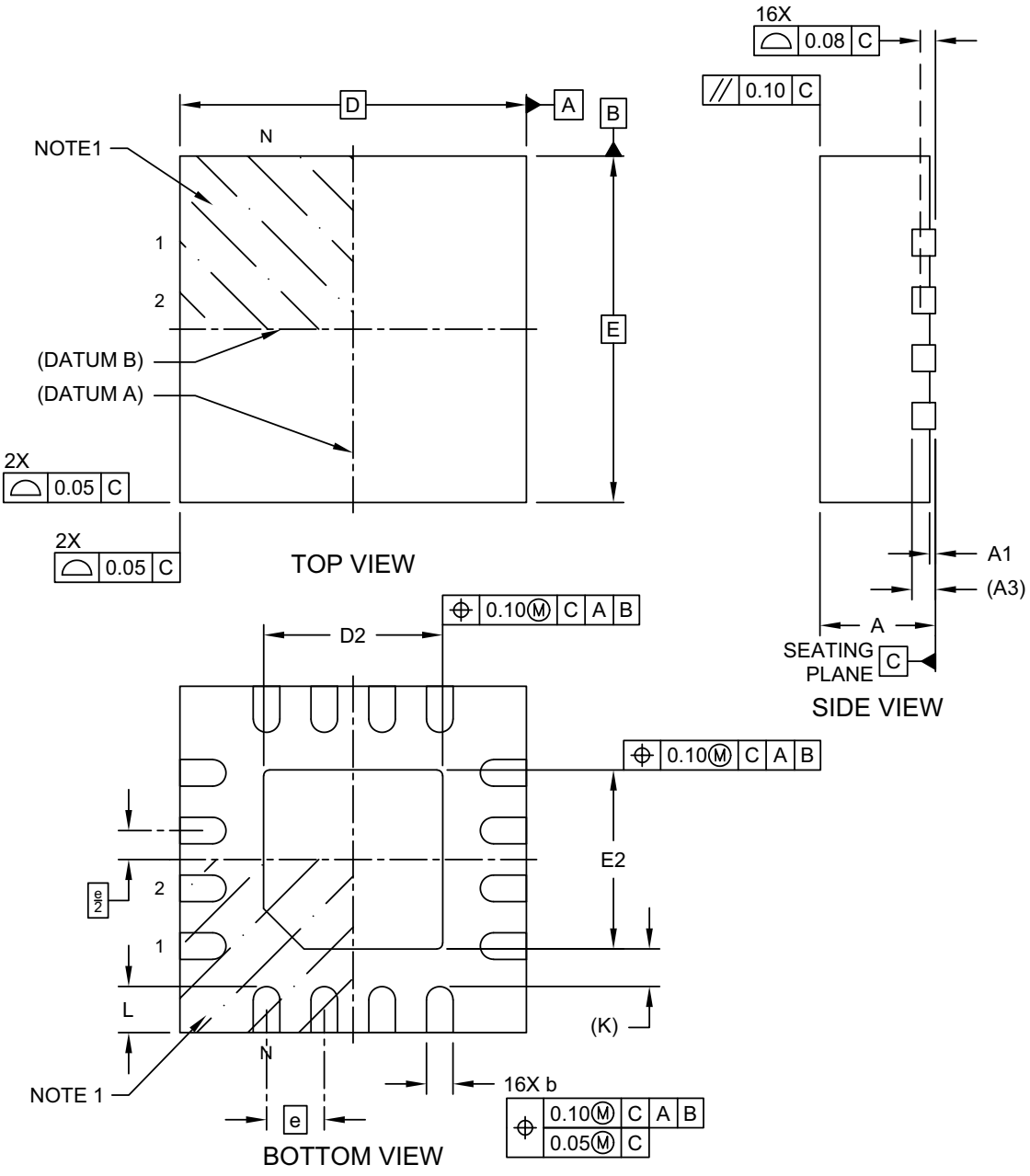
Example



Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.
	●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).
Note:	In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.	
	Underbar (_) and/or Overbar (¯) symbol may not be to scale.	

16-Lead Very Thin Plastic Quad Flat, No Lead Package (NCA) - 3x3x1.0 mm Body [VQFN] With 1.55 mm Exposed Pad; Micrel Legacy Package QFN33-16LD-PL-1

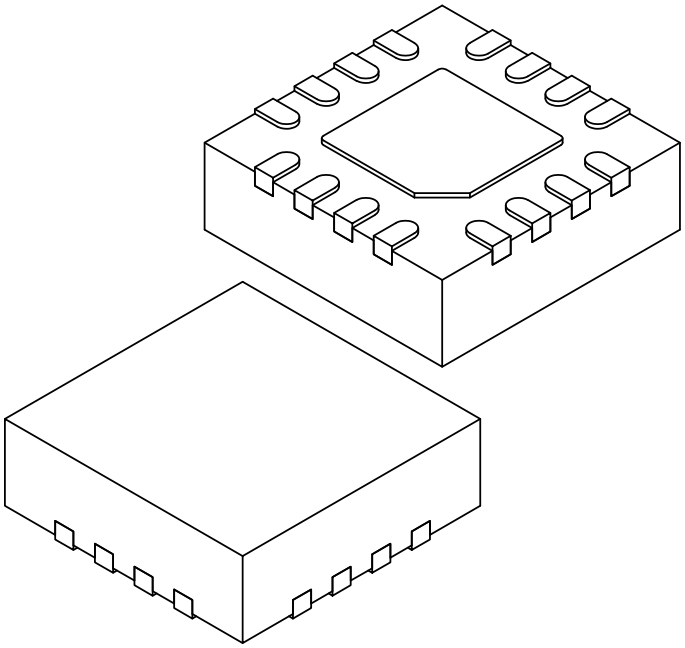
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-1103-NCA Rev C Sheet 1 of 2

16-Lead Very Thin Plastic Quad Flat, No Lead Package (NCA) - 3x3x1.0 mm Body [VQFN] With 1.55 mm Exposed Pad; Micrel Legacy Package QFN33-16LD-PL-1

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Terminals	N		16	
Pitch	e		0.50 BSC	
Overall Height	A	0.80	0.90	1.00
Standoff	A1	0.00	0.02	0.05
Terminal Thickness	A3		0.203 REF	
Overall Length	D		3.00 BSC	
Exposed Pad Length	D2	1.50	1.55	1.60
Overall Width	E		3.00 BSC	
Exposed Pad Width	E2	1.50	1.55	1.60
Terminal Width	b	0.18	0.23	0.28
Terminal Length	L	0.35	0.40	0.45
Terminal-to-Exposed-Pad	K		0.33 REF	

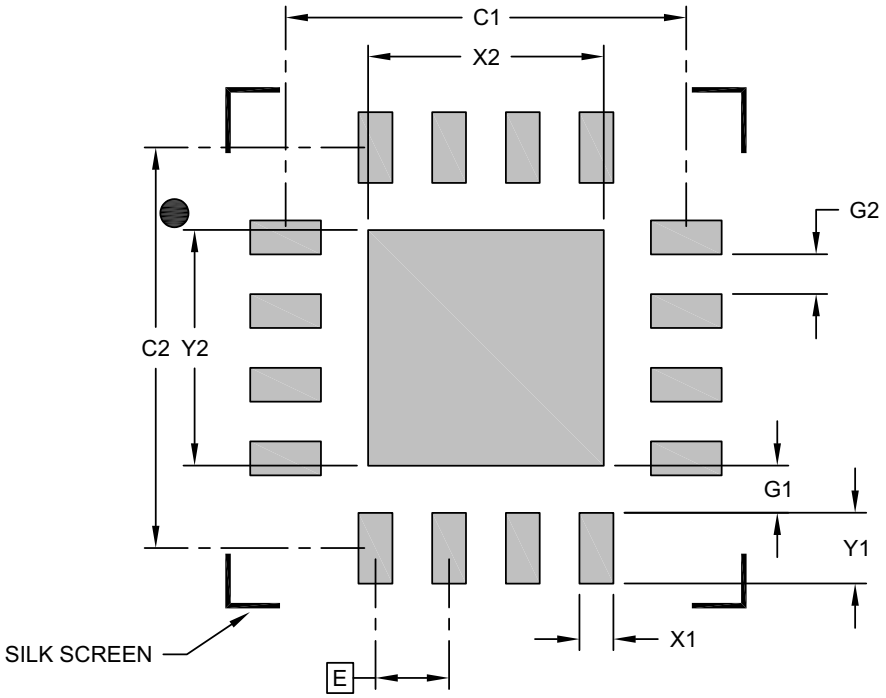
Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-1103-NCA Rev C Sheet 2 of 2

16-Lead Very Thin Plastic Quad Flat, No Lead Package (NCA) - 3x3x1.0 mm Body [VQFN] With 1.55 mm Exposed Pad; Micrel Legacy Package QFN33-16LD-PL-1

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.50 BSC	
Center Pad Width	X2			1.60
Center Pad Length	Y2			1.60
Contact Pad Spacing	C1		2.72	
Contact Pad Spacing	C2		2.72	
Contact Pad Width (Xnn)	X1			0.23
Contact Pad Length (Xnn)	Y1			0.48
Contact Pad to Center Pad (Xnn)	G1	0.32		
Contact Pad to Contact Pad (Xnn)	G2	0.27		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-3103-NCA Rev C

APPENDIX A: REVISION HISTORY

Revision A (August 2023)

- Converted Micrel document SY58022U to Microchip data sheet template DS20006800A.
- Swapped Figure 7-4 and Figure 7-5. These were sorted incorrectly in the legacy document.
- Minor text changes throughout.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

Part No.	X	X	X	-XX
Device	Supply Voltage	Package	Temperature Range	Media Type

Device:	SY58022:		5.5 GHz 1:4 Fanout Buffer/Translator with 400 mV LVPECL Outputs and Internal Input Termination
Supply Voltage:	U	=	2.5V/3.3V
Package:	M	=	3 mm x 3 mm 16-Lead VQFN
Temperature Range:	G	=	–40°C to +85°C
Media Type:	<blank>	=	100/Tube
	TR	=	1,000/Reel

Examples:

a) SY58022UMG:

SY58022, 2.5V/3.3V Supply Voltage, 16-Lead VQFN, –40°C to +85°C Temperature Range, 100/Tube

b) SY58022UMG-TR:

SY58022, 2.5V/3.3V Supply Voltage, 16-Lead VQFN, –40°C to +85°C Temperature Range, 1,000/Reel

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip product is strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is "unbreakable" Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.

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ISBN: 978-1-6683-2970-2

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