

# SY58021U

# 4 GHz, 1:4 LVPECL Fanout Buffer/Translator with Internal Termination

#### **Features**

- Precision 1:4 LVPECL Fanout Buffer
- · Low Jitter Performance
  - 70 fs<sub>RMS</sub> Phase Jitter (Typical)
- · Accepts an Input Signal as Low as 100 mV
- Unique Input Termination and VT Pin Accept DC-Coupled and AC-Coupled Differential Inputs: LVPECL, LVDS, and CML
- 100K LVPECL-Compatible 800 mV Swing Output
- Power Supply 2.5V ±5% and 3.3V ±10%
- -40°C to +85°C Temperature Range
- Available in 16-Lead, 3 mm x 3 mm VQFN Package

#### **Applications**

- · All SONET and GigE Clock Distribution
- · Fibre Channel Clock and Data Distribution
- · Backplane Distribution
- High-End, Low-Skew, Multiprocessor, Synchronous Clock Distribution

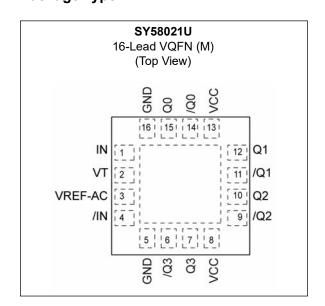
#### **General Description**

The SY58021U 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 output skew and only 70 fs<sub>RMS</sub> phase jitter, the SY58021U can process clock signals as fast as 4 GHz.

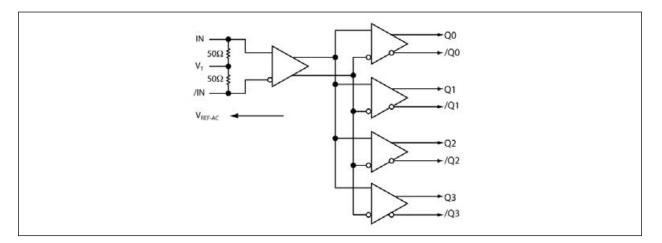
The differential input includes Microchip's unique, 3-pin input termination architecture interfaces to differential LVPECL, CML, and LVDS signals (AC- or DC-coupled) as small as 100 mV without any level-shifting or termination resistor networks in the signal path. For AC-coupled input interface applications, an on-board output reference voltage (V<sub>REFAC</sub>) is provided to bias the VT pin. The outputs are 100K LVPECL compatible, with extremely fast rise/fall times guaranteed to 70 ps.

The SY58021U operates from a 2.5V ±5% supply or 3.3V ±10% supply and is guaranteed over the full industrial temperature range (-40°C to +85°C). For applications that require faster rise/fall times, or greater bandwidth, consider the SY58022U 1:4 fanout buffer with 400 mV LVPECL output swing, or the SY58020U 1:4 CML fanout buffer. The SY58021U is part of Microchip's high-speed, Precision Edge<sup>®</sup> product line.

### **Package Type**



## **Functional Block Diagram**



#### 1.0 ELECTRICAL CHARACTERISTICS

#### **Absolute Maximum Ratings †**

Power Supply Voltage (V <sub>CC</sub> )	
Input Voltage (V <sub>IN</sub> )	
LVPECL Continuous Output Current (I <sub>OUT</sub> )	50 mA
LVPECL Surge Output Current (I <sub>OUT</sub> )	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<sub>CC</sub>).....+2.375V to +3.60V

**† Notice:** Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

**‡ Notice:** The device is not guaranteed to function outside its operating ratings.

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

#### INPUT DC ELECTRICAL CHARACTERISTICS

 $T_A = -40$ °C to +85°C. Note 1

Parameter	Symbol	Min.	Тур.	Max.	Units	Conditions
Dower Cumby Voltage	W	2.375	2.5	2.625	V	V <sub>CC</sub> = 2.5V
Power Supply Voltage	V <sub>CC</sub>	3.0	3.3	3.6	V	V <sub>CC</sub> = 3.3V
Power Supply Current	I <sub>CC</sub>	_	125	160	mA	No load, V <sub>CC</sub> = maximum
Input High Voltage	$V_{IH}$	V <sub>CC</sub> – 1.6	_	V <sub>CC</sub>	٧	IN, /IN (Note 2)
Input Low Voltage	$V_{IL}$	0	_	V <sub>IH</sub> – 0.1	V	IN, /IN
Input Voltage Swing	V <sub>IN</sub>	0.1	_	1.7	V	IN, /IN (See Figure 1-1)
Differential Input Voltage Swing	V <sub>DIFF_IN</sub>	0.2	_	_	V	IN, /IN (See Figure 1-2)
IN-to-VT Resistance	$R_{IN}$	40	50	60	Ω	_
IN-to-VT Voltage	V <sub>T_IN</sub>	_	_	1.28	V	_
Output Reference Voltage	V <sub>REF-AC</sub>	V <sub>CC</sub> – 1.3	V <sub>CC</sub> – 1.2	V <sub>CC</sub> – 1.1	V	_

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

2:  $V_{IH(MIN)}$  not lower than 1.2V.

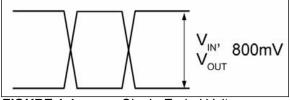
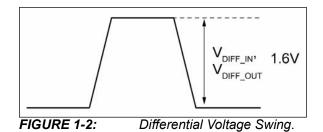


FIGURE 1-1: Single-Ended Voltage Swing.



#### LVPECL OUTPUT DC ELECTRICAL CHARACTERISTICS

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

Parameter	Symbol	Min.	Тур.	Max.	Units	Conditions
Output High Voltage	V <sub>OH</sub>	V <sub>CC</sub> – 1.145		V <sub>CC</sub> - 0.895	<b>&gt;</b>	_
Output Low Voltage	V <sub>OL</sub>	V <sub>CC</sub> – 1.945	_	V <sub>CC</sub> – 1.695	٧	_
Output Voltage Swing	V <sub>OUT</sub>	550	780	1050	mV	See Figure 1-1
Differential Output Voltage Swing	V <sub>DIFF_OUT</sub>	1100	1560	2100	mV	See Figure 1-2

**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 3.3 ±10%;  $R_L$  = 50 $\Omega$  to  $V_{CC}$  - 2V;  $T_A$  = -40°C to +85°C, unless otherwise stated.

Parameter	Symbol	Min.	Тур.	Max.	Units	Conditions
Maximum Operating	f	4	_	_	GHz	Clock, V <sub>OUT</sub> ≥ 400 mV
Frequency	f <sub>MAX</sub>	_	5	_	Gbps	Data, V <sub>OUT</sub> ≥ 400 mV
Propagation Delay	t <sub>PD</sub>	150	220	300	ps	_
Channel-to-Channel Skew	t <sub>CHAN</sub>	_	4	15	ps	Note 1
Part-to-Part Skew	t <sub>SKEW</sub>	_	_	30	ps	Note 2
RMS Phase Jitter	t <sub>JITTER</sub>	_	70	_	fs	Output: 622 MHz, Integration Range: 12 kHz to 20 MHz
Output Rise/Fall Time (20% to 80%)	t <sub>r</sub> ,t <sub>f</sub>	35	75	110	ps	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	Sym.	Min.	Тур.	Max.	Units	Conditions	
Temperature Ranges							
Storage Temperature Range	T <sub>S</sub>	-65	_	+150	°C	_	
Lead Temperature	T <sub>LEAD</sub>	_	_	+260	°C	Soldering, 20 sec.	
Operating Temperature Range	T <sub>A</sub>	-40	_	+85	°C	_	
Package Thermal Resistances							
	$\theta_{JA}$	_	60	_	°C/W	Still-Air	
Thermal Resistance, VQFN 16-Ld	$\theta_{JA}$	_	54	_	°C/W	500 lfpm	
morman resistance, von 10-Eu	ΨЈВ	_	33	_	°C/W	Junction-to-Board Resistance, Note 1	

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

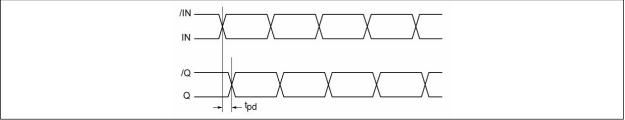


FIGURE 1-3: Timing Diagram.

#### 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.

 $V_{CC}$  = 2.5V, GND = 0V,  $V_{IN}$  = 100 mV,  $T_A$  = +25°C, unless otherwise stated.

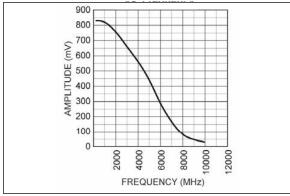


FIGURE 2-1: Amplitude vs. Frequency.

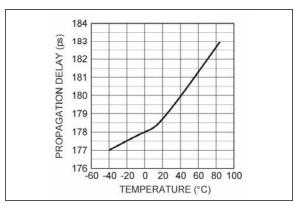


FIGURE 2-4: Propagation Delay vs. Temperature.

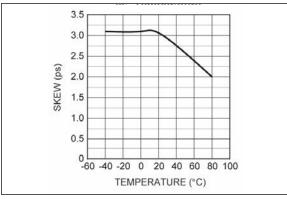


FIGURE 2-2: Skew vs. Temperature.

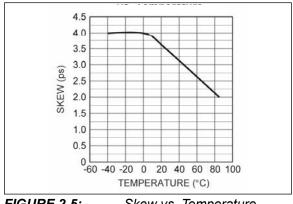


FIGURE 2-5: Skew vs. Temperature.

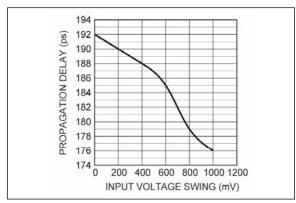


FIGURE 2-3: Propagation Delay vs. Input Voltage Swing.

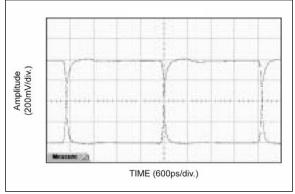
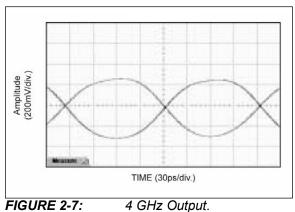
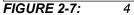


FIGURE 2-6: 200 MHz Output.





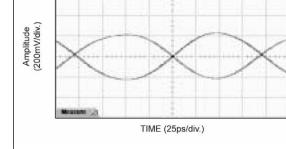


FIGURE 2-8:

5 GHz Output.

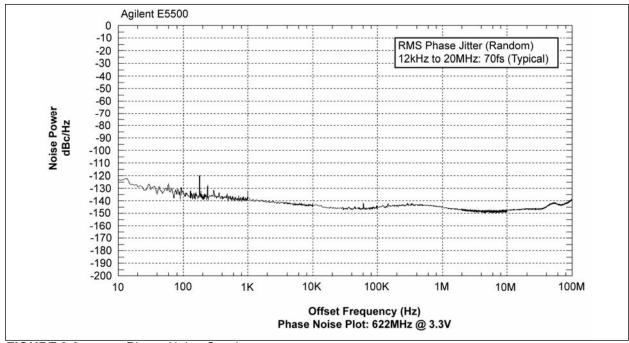


FIGURE 2-9:

Phase Noise Graph.

## 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 of this pair internally terminates with $50\Omega$ 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 $\mu$ F low ESR capacitor to VCC. See the "Input Interface Applications" section.
8, 13	VCC	Positive Power Supply: Bypass with 0.1 $\mu$ F//0.01 $\mu$ F low-ESR capacitors as close to the VCC pins as possible.
5, 16	GND, ePAD	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 800 mV Proper termination is $50\Omega$ to $V_{CC}-2V$ at the receiving end. Unused output pairs may be left floating with no impact on jitter or skew. See the "LVPECL Output Termination" section.

## Input Stage

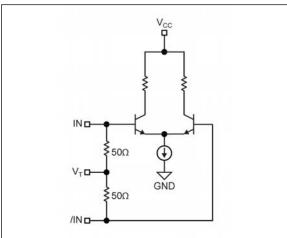


FIGURE 3-1: Simplified Differential Input Buffer.

## 4.0 INPUT INTERFACE APPLICATIONS

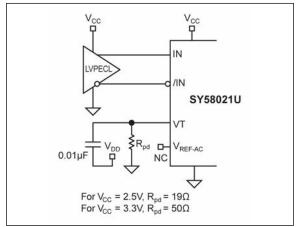


FIGURE 4-1: LVPECL Input Interface.

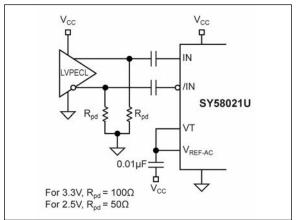


FIGURE 4-2: AC-Coupled LVPECL Input Interface.

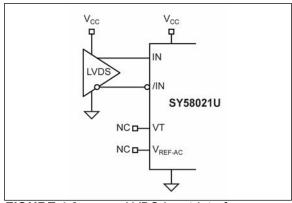


FIGURE 4-3: LVDS Input Interface.

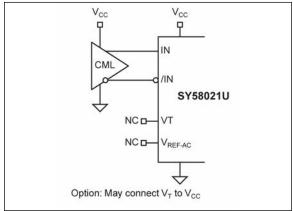


FIGURE 4-4: DC-Coupled CML Input Interface.

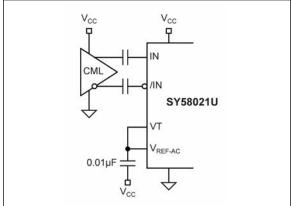


FIGURE 4-5: AC-Coupled CML Input Interface.

#### 5.0 LVPECL OUTPUT

LVPECL outputs have very-low output impedance (open emitter) and small signal swing, which results in low EMI. LVPECL is ideal for driving  $50\Omega$ - and  $100\Omega$ -controlled impedance transmission lines. There are several techniques in terminating the LVPECL output (Figure 5-1 through Figure 5-3).

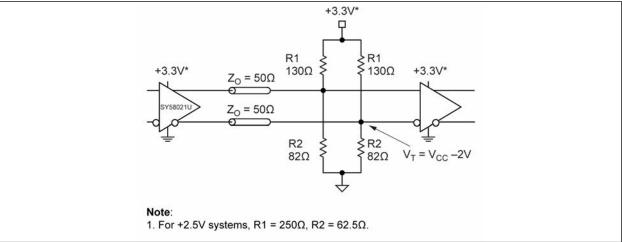


FIGURE 5-1: Parallel Termination: Thevenin Equivalent.

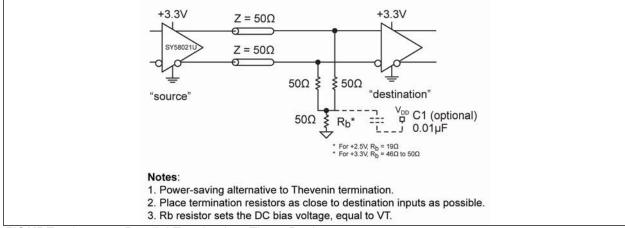


FIGURE 5-2: Parallel Termination: Three-Resistor.

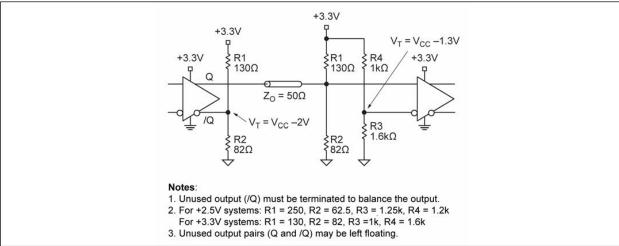


FIGURE 5-3: Terminating Unused I/O.

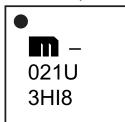
#### 6.0 PACKAGING INFORMATION

## 6.1 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

Pb-free JEDEC® designator for Matte Tin (Sn)

\* This package is Pb-free. The Pb-free JEDEC designator (@3)

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.

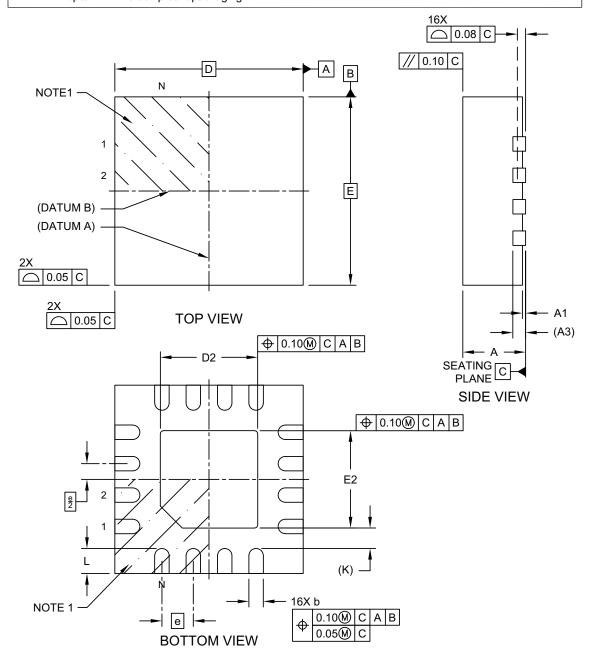
**Note:** If the full seven-character YYWWNNN code cannot fit on the package, the following truncated codes are used based on the available marking space:

6 Characters = YWWNNN; 5 Characters = WWNNN; 4 Characters = WNNN; 3 Characters = NNN;

2 Characters = NN; 1 Character = N

## 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

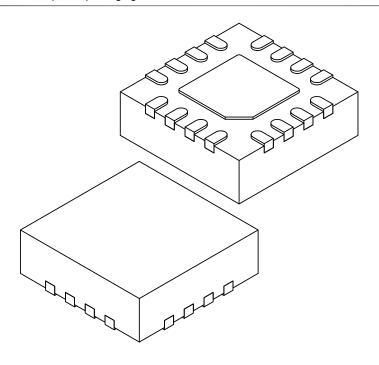
**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



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

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



	I.	IILLIMETER:	S		
Dimension	Limits	MIN	NOM	MAX	
Number of Terminals	N		16		
Pitch	е		0.50 BSC		
Overall Height	Α	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	Е	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

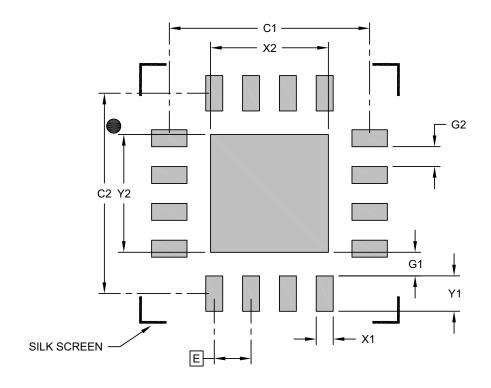
Dimensioning and tolerancing per ASME Y14.5M
 BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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

	MILLIMETERS				
Dimension	MIN	NOM	MAX		
Contact Pitch	Е		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

 ${\tt BSC: Basic \ Dimension. \ Theoretically \ exact \ value \ shown \ without \ tolerances.}$ 

Microchip Technology Drawing C04-3103-NCA Rev C

## APPENDIX A: REVISION HISTORY

## **Revision A (October 2023)**

- Converted Micrel document SY58021U to Microchip data sheet template DS20006822A.
- · Minor text changes throughout.

## PRODUCT IDENTIFICATION SYSTEM

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

Part No.	<u>X</u>	<u>x</u>	<u>X</u>	[- <u>XX</u> ]	Exampl	es:
Device	Supply Voltage	Package	Temperature Range	Media Type	a) SY58	3021UMG: SY58021, 2.5V/3.3V Supply Voltage, 16- Lead VQFN, –40°C to +85°C Temperature
Device:	SY58021:	4 GHz, 1:4 L\ with Internal	/PECL Fanout Buff Termination	er/Translator	Range, 100/Tube b) SY58021UMG-TR: SY58021, 2.5V/3.3V Supply Voltage,	
Supply Voltage:	U	= 2.5V/3	3.3V			Lead VQFN, –40°C to +85°C Temperature Range, 1,000/Reel
Package:	М	= 16-Le	ad 3 mm x 3 mm V	QFN	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
Temperature Range:	G	= -40°C	to +85°C			the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.
Media Type:	 tlank> TR	= 100/Ti = 1,000/				

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.

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. Contact your local Microchip sales office for additional support or, obtain additional support at <a href="https://www.microchip.com/en-us/support/design-help/client-support-services">https://www.microchip.com/en-us/support/design-help/client-support-services</a>.

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSEQUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP'S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION.

Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

#### **Trademarks**

The Microchip name and logo, the Microchip logo, Adaptec, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, CryptoMemory, CryptoRF, dsPlC, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Kleer, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AgileSwitch, ClockWorks, The Embedded Control Solutions Company, EtherSynch, Flashtec, Hyper Speed Control, HyperLight Load, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet-Wire, SmartFusion, SyncWorld, TimeCesium, TimeHub, TimePictra, TimeProvider, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, Augmented Switching, BlueSky, BodyCom, Clockstudio, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, Espresso T1S, EtherGREEN, EyeOpen, GridTime, IdealBridge, IGaT, In-Circuit Serial Programming, ICSP, INICnet, Intelligent Paralleling, IntelliMOS, Inter-Chip Connectivity, JitterBlocker, Knob-on-Display, MarginLink, maxCrypto, maxView, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, mSiC, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, Power MOS IV, Power MOS 7, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, RTAX, RTG4, SAM-ICE, Serial Quad I/O, simpleMAP, SimpliPHY, SmartBuffer, SmartHLS, SMART-I.S., storClad, SQI, SuperSwitcher, SuperSwitcher II, Switchtec, SynchroPHY, Total Endurance, Trusted Time, TSHARC, Turing, USBCheck, VariSense, VectorBlox, VeriPHY, ViewSpan, WiperLock, XpressConnect, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, and Symmcom are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2023, Microchip Technology Incorporated and its subsidiaries.

All Rights Reserved.

ISBN: 978-1-6683-3287-0

For information regarding Microchip's Quality Management Systems, please visit www.microchip.com/quality.



## Worldwide Sales and Service

#### **AMERICAS**

Corporate Office 2355 West Chandler Blvd. Chandler, AZ 85224-6199

Tel: 480-792-7200 Fax: 480-792-7277 Technical Support:

http://www.microchip.com/

support Web Address:

www.microchip.com

Atlanta Duluth, GA

Tel: 678-957-9614 Fax: 678-957-1455

**Austin, TX** Tel: 512-257-3370

**Boston** 

Westborough, MA Tel: 774-760-0087 Fax: 774-760-0088

Chicago Itasca, IL

Tel: 630-285-0071 Fax: 630-285-0075

Dallas

Addison, TX Tel: 972-818-7423 Fax: 972-818-2924

**Detroit** Novi. MI

Tel: 248-848-4000

Houston, TX Tel: 281-894-5983

Indianapolis

Noblesville, IN Tel: 317-773-8323 Fax: 317-773-5453 Tel: 317-536-2380

Los Angeles

Mission Viejo, CA Tel: 949-462-9523 Fax: 949-462-9608 Tel: 951-273-7800

**Raleigh, NC** Tel: 919-844-7510

New York, NY Tel: 631-435-6000

**San Jose, CA** Tel: 408-735-9110 Tel: 408-436-4270

Canada - Toronto Tel: 905-695-1980 Fax: 905-695-2078

#### ASIA/PACIFIC

Australia - Sydney Tel: 61-2-9868-6733

**China - Beijing** Tel: 86-10-8569-7000

China - Chengdu Tel: 86-28-8665-5511

China - Chongqing Tel: 86-23-8980-9588

**China - Dongguan** Tel: 86-769-8702-9880

**China - Guangzhou** Tel: 86-20-8755-8029

China - Hangzhou Tel: 86-571-8792-8115

China - Hong Kong SAR

Tel: 852-2943-5100 China - Nanjing

Tel: 86-25-8473-2460 China - Qingdao

Tel: 86-532-8502-7355 China - Shanghai

Tel: 86-21-3326-8000

**China - Shenyang** Tel: 86-24-2334-2829

**China - Shenzhen** Tel: 86-755-8864-2200

China - Suzhou

Tel: 86-186-6233-1526 China - Wuhan

Tel: 86-27-5980-5300 China - Xian

Tel: 86-29-8833-7252

**China - Xiamen** Tel: 86-592-2388138

**China - Zhuhai** Tel: 86-756-3210040

#### ASIA/PACIFIC

India - Bangalore Tel: 91-80-3090-4444

India - New Delhi Tel: 91-11-4160-8631

India - Pune

Tel: 91-20-4121-0141

**Japan - Osaka** Tel: 81-6-6152-7160

**Japan - Tokyo** Tel: 81-3-6880- 3770

Korea - Daegu Tel: 82-53-744-4301

Korea - Seoul Tel: 82-2-554-7200

Malaysia - Kuala Lumpur Tel: 60-3-7651-7906

Malaysia - Penang Tel: 60-4-227-8870

Philippines - Manila Tel: 63-2-634-9065

**Singapore** Tel: 65-6334-8870

**Taiwan - Hsin Chu** Tel: 886-3-577-8366

Taiwan - Kaohsiung Tel: 886-7-213-7830

**Taiwan - Taipei** Tel: 886-2-2508-8600

Thailand - Bangkok

Tel: 66-2-694-1351 Vietnam - Ho Chi Minh

Tel: 84-28-5448-2100

#### **EUROPE**

Austria - Wels

Tel: 43-7242-2244-39 Fax: 43-7242-2244-393

Denmark - Copenhagen Tel: 45-4485-5910

Fax: 45-4485-2829 Finland - Espoo

Tel: 358-9-4520-820

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Garching Tel: 49-8931-9700

**Germany - Haan** Tel: 49-2129-3766400

Germany - Heilbronn Tel: 49-7131-72400

**Germany - Karlsruhe** Tel: 49-721-625370

**Germany - Munich** Tel: 49-89-627-144-0 Fax: 49-89-627-144-44

Germany - Rosenheim Tel: 49-8031-354-560

Israel - Ra'anana Tel: 972-9-744-7705

Italy - Milan Tel: 39-0331-742611

Fax: 39-0331-466781

**Italy - Padova** Tel: 39-049-7625286

**Netherlands - Drunen** Tel: 31-416-690399 Fax: 31-416-690340

Norway - Trondheim Tel: 47-7288-4388

**Poland - Warsaw** Tel: 48-22-3325737

Romania - Bucharest Tel: 40-21-407-87-50

**Spain - Madrid** Tel: 34-91-708-08-90 Fax: 34-91-708-08-91

**Sweden - Gothenberg** Tel: 46-31-704-60-40

Sweden - Stockholm Tel: 46-8-5090-4654

**UK - Wokingham** Tel: 44-118-921-5800 Fax: 44-118-921-5820