



SG1524B/SG2524B/SG3524B Regulating Pulse Width Modulator

Table of Contents

1. Product Overview.....	3
1.1. Features.....	3
1.2. High Reliability Features.....	3
1.3. Block Diagram.....	3
2. Electrical Specifications.....	5
2.1. Recommended Operating Conditions.....	7
2.2. Typical Performance Curves.....	8
2.3. Absolute Maximum Ratings.....	9
3. Package Information.....	11
3.1. Thermal Data	15
4. Ordering Information.....	17
5. Revision History.....	19
The Microchip Website.....	20
Product Change Notification Service.....	20
Customer Support.....	20
Microchip Devices Code Protection Feature.....	20
Legal Notice.....	21
Trademarks.....	21
Quality Management System.....	22
Worldwide Sales and Service.....	23

1. Product Overview

The SG1524B is a pulse width modulator for switching power supplies, that gives improved performance over industry standards, like the SG1524. This is a direct pin-for-pin replacement for the earlier device, and combines advanced processing techniques and circuit design to provide improved reference accuracy, and extended common mode range at the error amplifier and current limit inputs. A DC-coupled flip-flop eliminates triggering and glitch problems, and a pulse width modulator data latch prevents edge oscillations. The circuit incorporates true digital shutdown for high speed response, while an under voltage lockout circuit prevents spurious outputs when the supply voltage is too low for stable operation. Full double-pulse suppression logic insures alternating output pulses when the shutdown pin is used for pulse-by-pulse current limiting. SG1524B is specified for operation over the full military ambient temperature range of -55°C to 125°C . SG2524B is characterized for the industrial range of -25°C to 85°C , and SG3524B is designed for the commercial range of 0°C to 70°C .

1.1 Features

The main features of SG1524B are as follows.

- 7 V to 40 V operation
- 5 V reference trimmed to $\pm 1\%$
- 100 Hz to 400 kHz oscillator range
- Excellent external sync capability
- Dual 100 mA output transistors
- Wide current limit common mode range
- DC-coupled toggle flip-flop
- PWM data latch
- Undervoltage lockout
- Full double pulse suppression logic
- 60 V output collectors

1.2 High Reliability Features

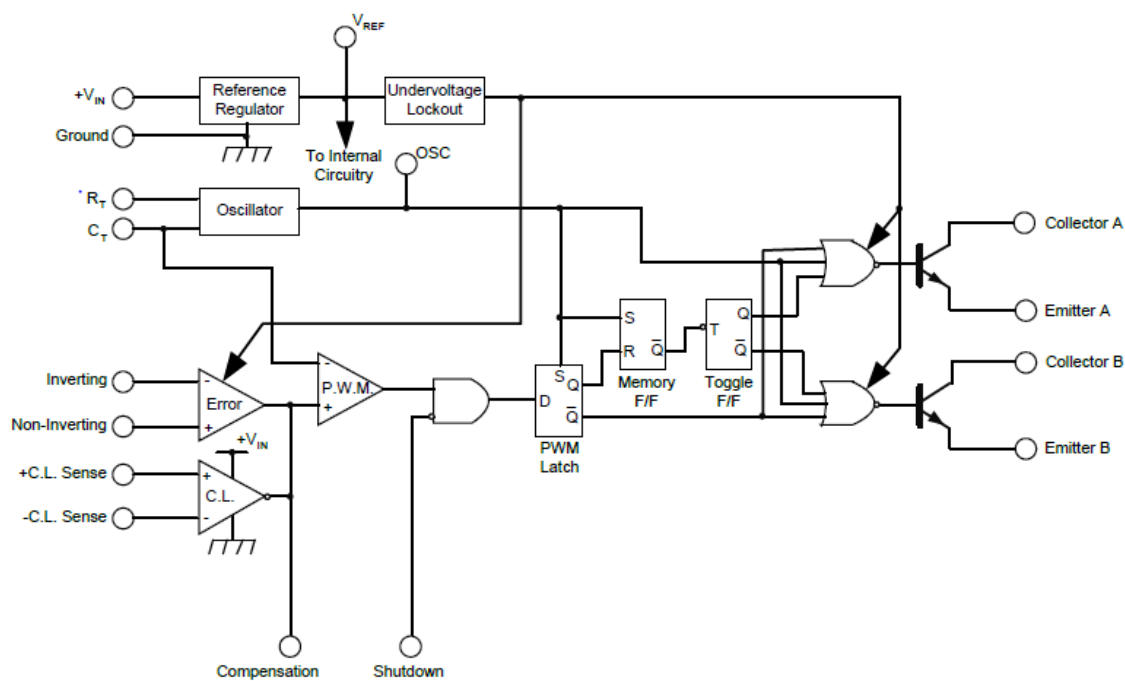
The high reliability features of SG1524B are as follows.

- Available to MIL-STD-883, ¶ 1.2.1
- MSC-AMS level "S" processing available
- Available to DSCC-standard microcircuit drawing (SMD)

1.3 Block Diagram

The following figure shows the block diagram of SG1524B.

Figure 1-1. SG1524B Block Diagram



2. Electrical Specifications

This section shows the electrical characteristics of SG1524B/SG2524B/SG3524B. If not specified, these specifications apply over the operating ambient temperatures for SG1524B with $-55\text{ }^{\circ}\text{C} \leq T_A \leq 125\text{ }^{\circ}\text{C}$, SG2524B with $-25\text{ }^{\circ}\text{C} \leq T_A \leq 85\text{ }^{\circ}\text{C}$, SG3524B with $0\text{ }^{\circ}\text{C} \leq T_A \leq 70\text{ }^{\circ}\text{C}$, and $V_{IN} = 20\text{ V}$. Low duty cycle pulse testing techniques are used, that maintain junction and case temperatures equal to the ambient temperature.

The following table shows the parameters and test conditions of SG1524B/SG2524B/SG3524B.

Table 2-1. Electrical Characteristics

Parameter	Test Conditions	SG1524B			SG2524B			SG3524B			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Reference Section (I _L = 0 mA)											
Output voltage	T _J = 25 °C	4.95	5.00	5.05	4.95	5.00	5.05	4.90	5.00	5.10	V
Line regulation	V _{IN} = 7 V to 40 V		3	20		3	20		3	30	mV
Load regulation	I _L = 0 mA to 20 mA		5	30		5	30		5	50	mV
Temperature stability ¹	Over operating temperature range		15	50		15	50		15	50	mV
Total output voltage range	Over line, load and temperature	4.90		5.10	4.90		5.10	4.80		5.20	V
Short circuit current	V _{REF} = 0 V	25	50	120	25	50	120	25	50	120	mA
Undervoltage Lockout Section											
Threshold voltage		4.3	4.5	4.7	4.20	4.5	4.7	4.2	4.5	4.9	V
Oscillator Section (F _{OSC} = 45 kHz, R _T = 2700 Ω, C _T = 0.01 μF)											
Initial accuracy	T _J = 25 °C	42	45	48	42	45	48	40	45	50	kHz
Voltage stability	V _{IN} = 7 V to 40 V		0.1	1		0.1	1		0.1	1	%
Temperature stability ¹	Over operating range		1	2		1	2		1	2	%
Minimum frequency ¹	R _T = 150 kΩ, C _T = 0.1 μF		50	140		50	140		50	120	Hz
Maximum frequency	R _T = 2 kΩ, C _T = 470 pF	400	600		400	600		400	600		kHz
Sawtooth peak voltage	V _{IN} = 40 V		3.5	3.9		3.5	3.9		3.5	3.9	V
Sawtooth valley voltage	V _{IN} = 7 V	0.6	1		0.6	1		0.6	1		V

Electrical Specifications

.....continued

Parameter	Test Conditions	SG1524B			SG2524B			SG3524B			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Clock amplitude		3.0	4.0		3.0	4.0		3.0	4.0		V
Clock pulse width		0.2	0.5	1.2	0.2	0.5	1.2	0.2	0.5	1.2	μs
Error Amplifier Section ($V_{CM} = 2.3\text{ V}$ to V_{REF})											
Input offset voltage	$R_S \leq 2\text{ k}\Omega$		0.5	5		0.5	5		2	10	mV
Input bias current			1	5		1	5		1	10	μA
Input offset current				1			1			1	μA
DC open loop gain	$R_L \geq 10\text{ M}\Omega$	60	78		60	78		60	78		dB
Output low level	$I_{SINK} = 100\text{ }\mu\text{A}$ $V_{PIN\ 1} - V_{PIN\ 2} \geq 150\text{ mV}$		0.2	0.5		0.2	0.5		0.2	0.5	V
Output high level	$I_{SOURCE} = 100\text{ }\mu\text{A}$ $V_{PIN\ 2} - V_{PIN\ 1} \geq 150\text{ mV}$	3.8	4.2		3.8	4.2		3.8	4.2		V
Common mode rejection	$V_{CM} = 2.3\text{ V}$ to V_{REF}	70	90		70	90		70	90		dB
Supply voltage rejection	$V_{IN} = 7\text{ V}$ to 40 V	76	100		76	100		76	100		dB
Gain-bandwidth product ¹	$T_J = 25\text{ }^\circ\text{C}$	1	2		1	2		1	2		MHz
P.W.M. Comparator ($F_{OSC} = 45\text{ kHz}$, $R_T = 2700\text{ }\Omega$, $C_T = 0.01\text{ }\mu\text{F}$)											
Minimum duty cycle	$V_{COMP} = 0.5\text{ V}$			0			0			0	%
Maximum duty cycle	$V_{COMP} = 3.9\text{ V}$	45	49		45	49		45	49		%
Current Limit Amplifier Section ($V_{CM} = 0\text{ V}$ to 17.5 V)											
Sense voltage		180	200	220	180	200	220	170	200	230	mV
Input bias current			-3	-10		-3	-10		-3	-10	μA

.....continued

Parameter	Test Conditions	SG1524B			SG2524B			SG3524B			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Shutdown Input Section											
High input voltage		2.0			2.0			2.0			V
High input current	V _{SHUTDOWN} = 5 V		0.10	1		0.10	1		0.10	1	mA
Low input voltage				0.6			0.6			0.6	V
Output Section for Each Transistor											
Collector leakage current	V _{CE} = 60 V			50			50			50	μA
Collector saturation voltage	I _C = 10 mA I _C = 100 mA		0.2 1.0	0.4 2.0		0.2 1.0	0.4 2.0		0.2 1.0	0.4 2.0	V
Emitter output voltage	I _E = 10 mA I _E = 100 mA	17.5 17	19 18		17.5 17	19 18		17.5 17	19 18		V
Emitter voltage rise time ¹	R _E = 2 kΩ, T _A = 25 °C		0.2	0.5		0.2	0.5		0.2	0.5	μs
Collector voltage fall time	R _C = 2 kΩ, T _A = 25 °C		0.1	0.2		0.1	0.2		0.1	0.2	μs
Power Consumption											
Standby current	V _{IN} = 40 V, V _{SHUTDOWN} = 2.0 V		5	12		5	12		5	12	mA

1. These parameters, although guaranteed over the recommended operating conditions, are not tested in production.

2.1 Recommended Operating Conditions

The following table shows recommended operating conditions of SG1524B/SG2524B/SG3524B. Here, the operating conditions refer to ranges over which the device is functional.

Table 2-2. Recommended Operating Conditions

Parameter	Value	Unit
Input voltage (V_{IN})	7 to 40	V
Collector voltage	0 to 60	V
Error Amp common mode range	2.3 to V_{REF}	V
Current limit sense common mode range	0 to $V_{IN} - 2.5\text{ V}$	V

.....continued

Parameter	Value	Unit
Output current (each transistor)	0 to 100	mA
Reference load current	0 to 20	mA
Oscillator charging current	25 to 1.8	$\mu\text{A}/\text{mA}$
Oscillator frequency range	100 to 400	Hz/kHz
Oscillator timing resistor (R_T)	2 to 150	k Ω
Oscillator timing capacitor (C_T)	1 to 0.1	nF/ μF
Operating Ambient Temperature Range		
SG1524B	-55 to 125	$^{\circ}\text{C}$
SG2524B	-25 to 85	$^{\circ}\text{C}$
SG3524B	0 to 70	$^{\circ}\text{C}$

2.2 Typical Performance Curves

The following figures show characteristic curves of SG1524B. The conditions are, $V_{IN} = 20\text{ V}$, $T_A = 25\text{ }^{\circ}\text{C}$.

Figure 2-1. Oscillator Frequency vs. Timing Resistor and Capacitor

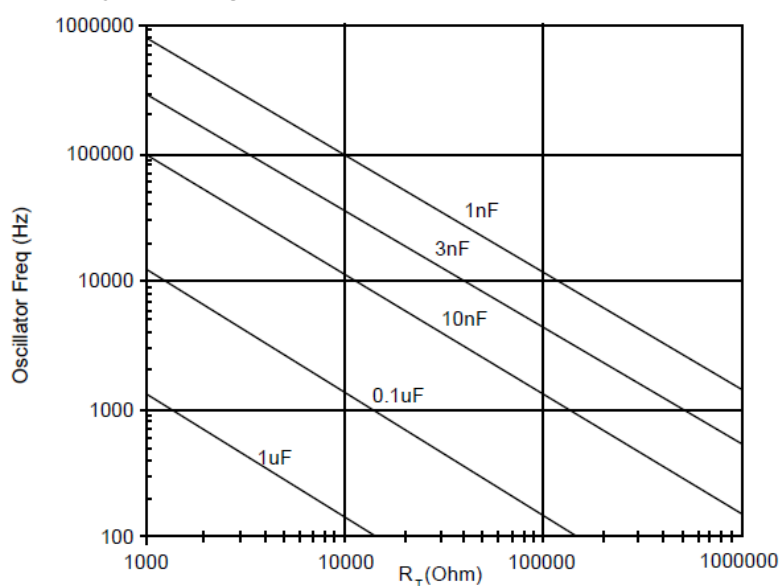


Figure 2-2. SG1524B Dead Times vs. Timing Capacitance ($R_T = 2.7 \text{ k}\Omega$)

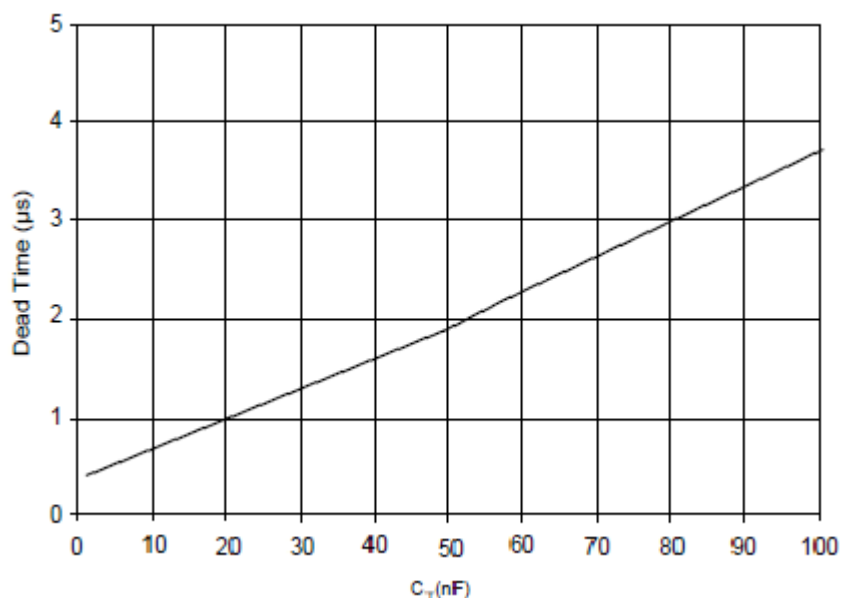
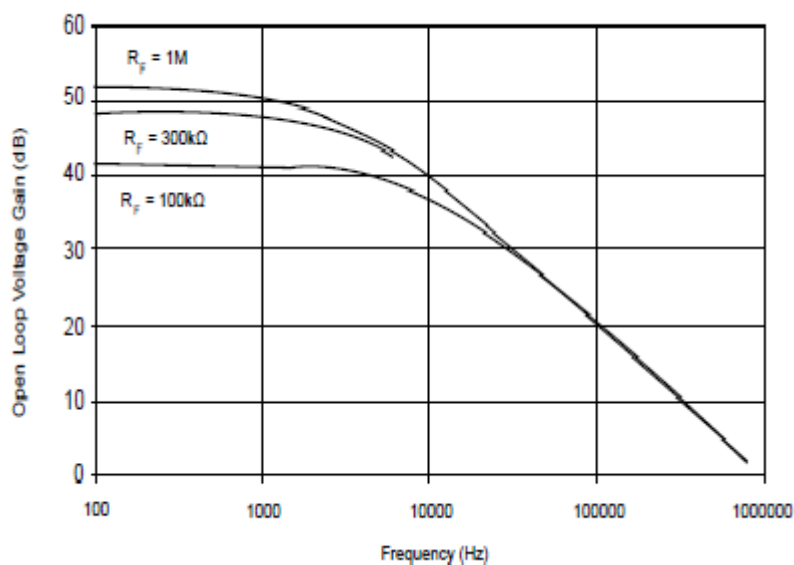


Figure 2-3. SG1524B Error Amplitude Voltage Gain vs. Frequency over R_F



2.3 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of SG1524B/SG2524B/SG3524B. The absolute maximum ratings refer to values beyond which damage may occur.

Table 2-3. Absolute Maximum Ratings

Parameter	Value	Units
Input voltage ($+V_{IN}$)	42	V

.....continued

Parameter	Value	Units
Collector voltage	60	V
Logic inputs	−0.3 to 5.5	V
Current limit sense inputs	−0.3 to V_{IN}	V
Output current (each transistor)	200	mA
Reference load current	50	mA
Oscillator charging current	5	mA
Operating Junction Temperature		
Hermetic (J and L Packages)	150	°C
Plastic (N and DW Packages)	150	°C
Storage temperature range	−65 to 150	°C
Lead temperature (soldering, 10 seconds)	300	°C
RoHS peak package solder reflow temperature (40 seconds maximum exposure)	260 (+0, −5)	°C

3. Package Information

This section shows the package outline dimensions and thermal specifications of SG1524B/SG2524B/SG3524B. Controlling dimensions are in inches, and metric equivalents are shown for general information.

The following figure and table show DW 16-pin SOWB package and its dimensions. Dimensions do not include protrusions and should not exceed 0.155 mm (0.006 in.) on any side. Lead dimension should not include solder coverage.

Figure 3-1. DW 16-Pin SOWB Package

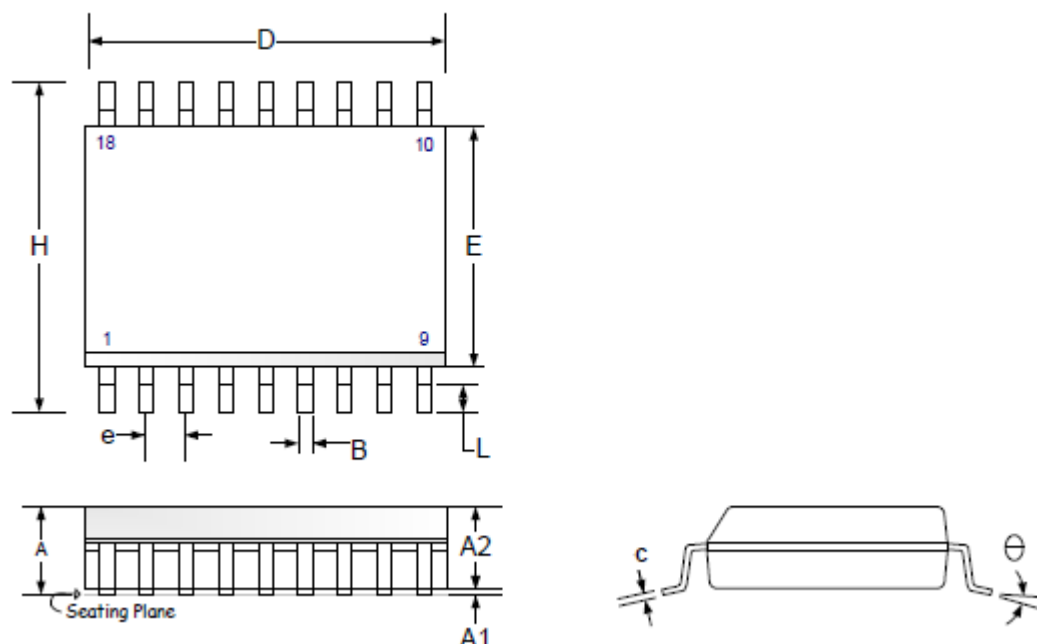


Table 3-1. DW 16-Pin SOWB Package Dimensions

Dimensions	Millimeters		Inches	
	Minimum	Maximum	Minimum	Maximum
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.52	0.049	0.060
b	0.33	0.51	0.013	0.020
c	0.19	0.25	0.007	0.010
D	9.78	10.01	0.385	0.394
E	5.79	6.20	0.228	0.244
e	1.27 BSC		0.050 BSC	
H	3.81	4.01	0.150	0.158
L	0.40	1.27	0.016	0.050

.....continued

Dimensions	Millimeters		Inches	
	Minimum	Maximum	Minimum	Maximum
Θ	0	8	0	8
Lead coplanarity		0.10		0.004

The following figure and table show N 16-pin plastic dual inline package and its dimensions. Dimensions do not include protrusions and should not exceed 0.155 mm (0.006 in.) on any side. Lead dimension should not include solder coverage.

Figure 3-2. N 16-Pin Plastic Dual Inline Package

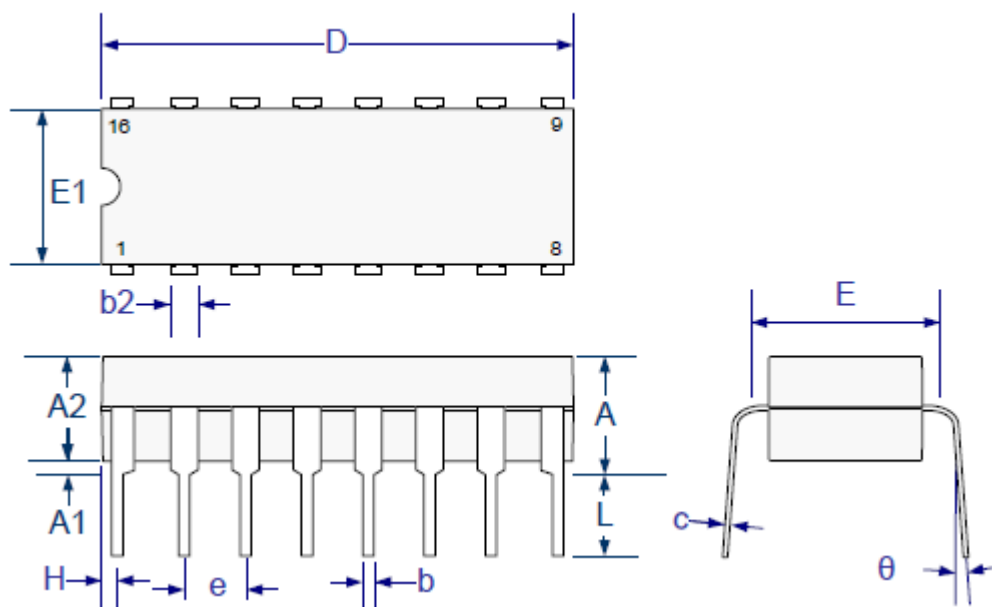


Table 3-2. N 16-Pin Plastic Dual Inline Package Dimensions

Dimensions	Millimeters		Inches	
	Minimum	Maximum	Minimum	Maximum
A	–	5.08	–	0.200
A1	0.38	0.51	0.015	0.040
A2	3.30 typical		0.130 typical	
b	0.38	0.51	0.015	0.020
b2	0.76	1.52	0.030	0.060
c	0.20	0.38	0.008	0.015
D	18.54	20.57	0.730	0.810
e	2.54 BSC		0.100 BSC	
E1	6.10	6.60	0.240	0.260

.....continued

Dimensions	Millimeters		Inches	
	Minimum	Maximum	Minimum	Maximum
E	7.62 BSC		0.300 BSC	
L	3.05	-	0.120	-
θ	-	15°	-	15°

The following figure and table show J 16-pin ceramic dual inline package and its dimensions. Dimensions do not include protrusions and should not exceed 0.155 mm (0.006 in.) on any side. Lead dimension should not include solder coverage.

Figure 3-3. J 16-Pin Ceramic Dual Inline Package

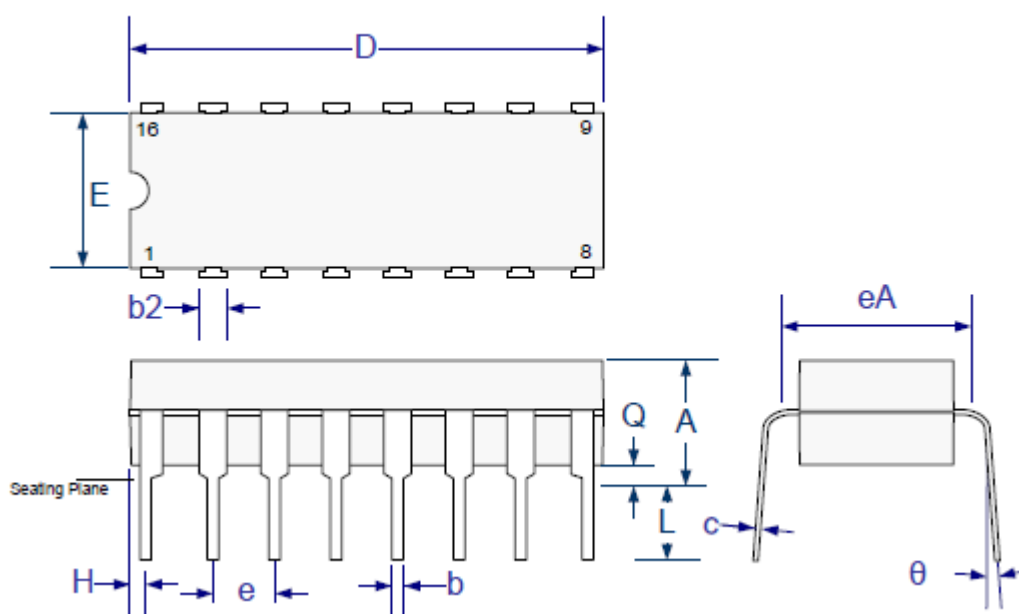


Table 3-3. J 16-Pin Ceramic Dual Inline Package Dimensions

Dimensions	Millimeters		Inches	
	Minimum	Maximum	Minimum	Maximum
A	-	5.08	-	0.200
b	0.38	0.51	0.015	0.020
b2	1.04	1.65	0.045	0.065
c	0.20	0.38	0.008	0.015
D	19.30	19.94	0.760	0.785
E	5.59	7.11	0.220	0.280
e	2.54 BSC		0.100 BSC	

.....continued

Dimensions	Millimeters		Inches	
eA	7.37	7.87	0.290	0.310
H	0.63	1.78	0.025	0.070
L	3.18	5.08	0.125	0.200
α	-	15°	-	15°
Q	0.51	1.02	0.020	0.040

The following figure and table show L 20-pin ceramic leadless chip carrier (CLCC) package and its outline dimensions. All exposed metalized area should be gold plated, 60 micro-inch minimum thickness over nickel plated base, if not specified in purchase order.

Figure 3-4. L 20-Pin Ceramic Leadless Chip Carrier (CLCC) Package

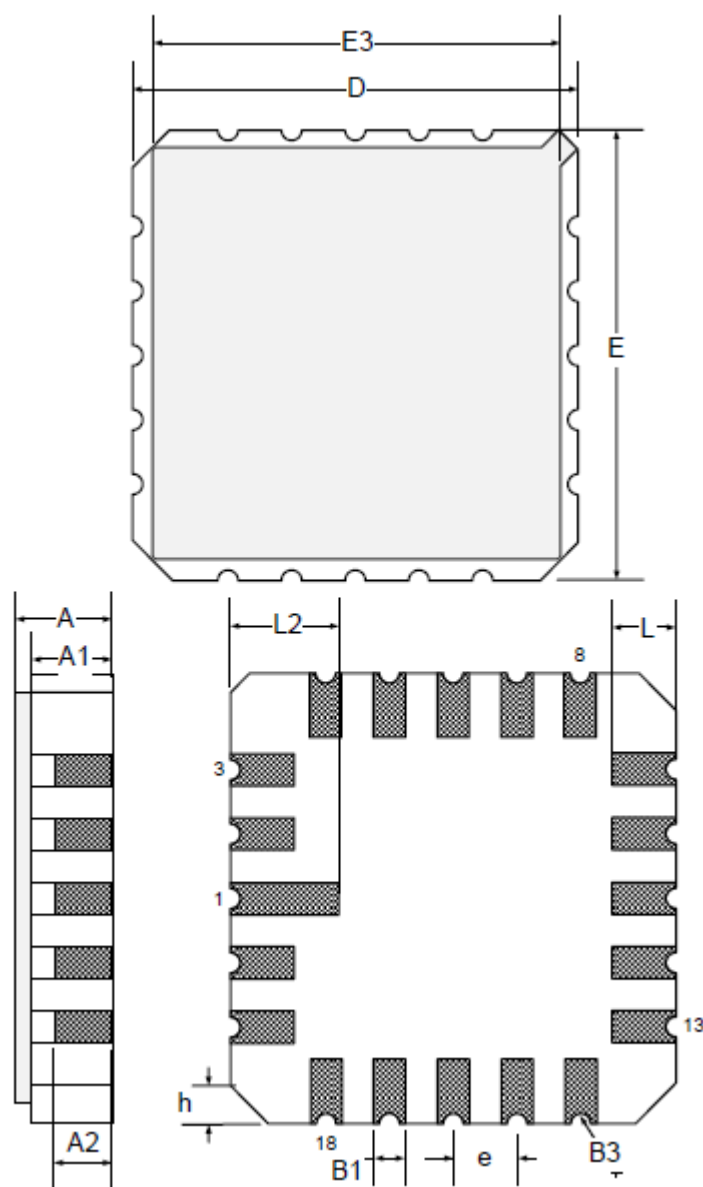


Table 3-4. L 20-Pin Ceramic Leadless Chip Carrier (CLCC) Package Outline Dimensions

DIM	Millimeters		Inches	
	Minimum	Maximum	Minimum	Maximum
D/E	8.64	9.14	0.340	0.360
E3	-	8.128	-	0.320
e	1.270 BSC		0.050 BSC	
B1	0.635 typical		0.025 typical	
L	1.02	1.52	0.040	0.060
A	1.626	2.286	0.064	0.090
h	1.016 typical		0.040 typical	
A1	1.372	1.68	0.054	0.066
A2	—	1.168	—	0.046
L2	1.91	2.41	0.075	0.95
B3	0.203 R		0.008 R	

3.1 Thermal Data

The following table shows the thermal data specifications of SG1524B/SG2524B/SG3524B.

Table 3-5. Thermal Data Specifications

Parameter	Value	Units
J Package		
Thermal resistance-junction to case, θ_{JC}	30	°C/W
Thermal resistance-junction to ambient, θ_{JA}	80	°C/W
N Package		
Thermal resistance-junction to case, θ_{JC}	40	°C/W
Thermal resistance-junction to ambient, θ_{JA}	65	°C/W
DW Package		
Thermal resistance-junction to case, θ_{JC}	40	°C/W
Thermal resistance-junction to ambient, θ_{JA}	95	°C/W
L Package		
Thermal resistance-junction to case, θ_{JC}	35	°C/W
Thermal resistance-junction to ambient, θ_{JA}	120	°C/W

Note:

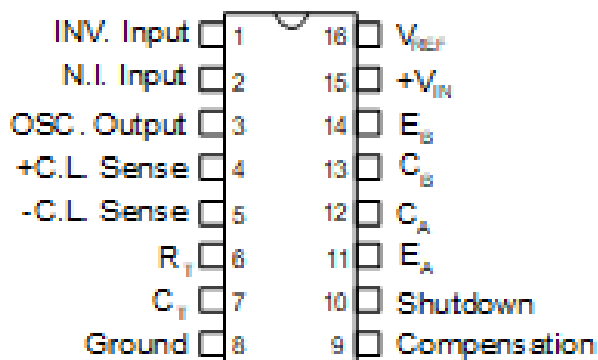
- Junction temperature calculation: $T_J = T_A + (P_D \times \theta_{JA})$.

- The above numbers for θ_{JC} are maximum for the limiting thermal resistance of the package in a standard mounting configuration. The θ_{JA} numbers are meant to be guidelines for the thermal performance of the device or pc-board system. All of the above assume no ambient airflow.

4. Ordering Information

The following figures and tables show the connection diagrams and ordering information of SG1524B.

Figure 4-1. 16-Pin Dual Inline Package

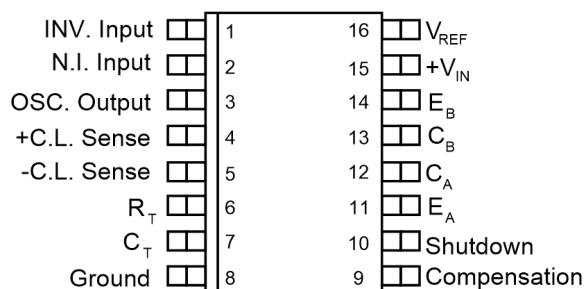


- N Package: RoHS complaint/Pb-free transition DC: 0503
- N Package: RoHS/Pb-free 100% matte tin lead finish

Table 4-1. Ordering Information of 16-Pin Dual Inline Package

Ambient Temperature	Type	Package	Part Number	Packaging Type
-55 °C to 125 °C	J	16-pin ceramic dual inline package	SG1524BJ	CERDIP (ceramic dual in-line package)
			SG1524BJ-883B	
			SG1524BJ-DESC	
-25 °C to 85 °C	N	16-pin dual inline plastic package	SG2524BN	PDIP (plastic dual in-line package)
0 °C to 70 °C			SG3524BN	

Figure 4-2. 16-Pin Small Outline Wide Body Package



- DW Package: RoHS complaint/Pb-free transition DC: 0516
- DW Package: RoHS/Pb-free 100% matte tin lead finish

Table 4-2. Ordering Information of 16-Pin Small Outline Wide Body Package

Ambient Temperature	Type	Package	Part Number	Packaging Type
-25 °C to 85 °C	DW	16-pin small outline wide body package	SG2524BDW	SOWB
0 °C to 70 °C			SG3524BDW	

Figure 4-3. 20-Pin Ceramic Leadless Chip Carrier

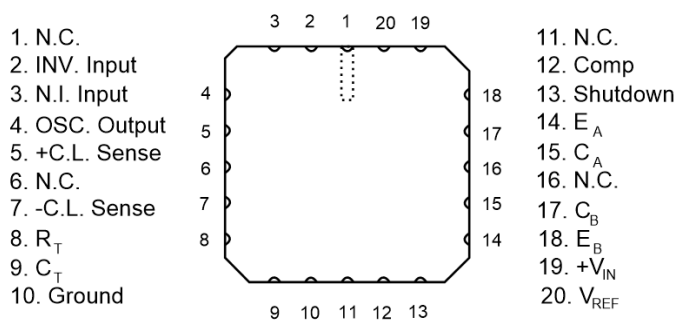


Table 4-3. Ordering Information of 20-Pin Ceramic Leadless Chip Carrier

Ambient Temperature	Type	Package	Part Number	Packaging Type
-55 °C to 125 °C	L	20-pin ceramic leadless chip carrier	SG1524BL-883B	CLCC
			SG1524BL	

Note:

- Contact your Microsemi representative for DESC product availability.
- All packages are viewed from the top.
- Hermetic packages, J and L use Sn63/Pb37 hot solder lead finish. Contact your Microsemi representative for availability of RoHS versions.
- Available in tape and reel. Append the letters "TR" to the part number (i.e., SG3524BDW-TR).

5. Revision History

Table 5-1. Revision History

Revision	Date	Description
A	08/2021	Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00004165A, which replaces the previous Microsemi literature number SG1524B-2.00-0718.
2.0 (Microsemi)	07/2018	• Corrected typo in the title of the document. • Edited formatting.
1.4 (Microsemi)	12/2014	• Corrected typo in the Features section. • Corrected typo in the Ordering Information section.
1.1 (Microsemi)	02/1994	Document created.

The Microchip Website

Microchip provides online support via our website at www.microchip.com/. This website is used to make files and information easily available to customers. Some of the content available includes:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip design partner program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

Product Change Notification Service

Microchip's product change notification service helps keep customers current on Microchip products. Subscribers will receive email notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, go to www.microchip.com/pcn and follow the registration instructions.

Customer Support

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Embedded Solutions Engineer (ESE)
- Technical Support

Customers should contact their distributor, representative or ESE for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in this document.

Technical support is available through the website at: www.microchip.com/support

Microchip Devices Code Protection Feature

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

- 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 and under normal conditions.
- There are dishonest and possibly illegal methods being used in attempts to breach the code protection features of the Microchip devices. We believe that these methods require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Attempts to breach these code protection features, most likely, cannot be accomplished without violating Microchip's intellectual property rights.
- Microchip is willing to work with any customer who is concerned about the integrity of its code.
- 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. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Legal Notice

Information contained in this publication is provided for the sole purpose of designing with and using Microchip products. Information regarding device applications and the like 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.

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, AnyRate, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, chipKIT, chipKIT logo, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Kleer, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PackeTime, 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, APT, ClockWorks, The Embedded Control Solutions Company, EtherSynch, FlashTec, Hyper Speed Control, HyperLight Load, IntelliMOS, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet-Wire, SmartFusion, SyncWorld, Temux, TimeCesium, TimeHub, TimePictra, TimeProvider, WinPath, 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, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, Espresso T1S, EtherGREEN, IdealBridge, In-Circuit Serial Programming, ICSP, INICnet, Intelligent Paralleling, Inter-Chip Connectivity, JitterBlocker, maxCrypto, maxView, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICKit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, RTAX, RTG4, SAM-ICE, Serial Quad I/O, simpleMAP, SimpliPHY, SmartBuffer, SMART-I.S., storClad, SQL, SuperSwitcher, SuperSwitcher II, Switchtec, SynchroPHY, Total Endurance, TSHARC, 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.

© 2021, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

ISBN: 978-1-5224-8798-2

Quality Management System

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

Worldwide Sales and Service

AMERICAS	ASIA/PACIFIC	ASIA/PACIFIC	EUROPE
Corporate Office 2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200 Fax: 480-792-7277 Technical Support: www.microchip.com/support Web Address: www.microchip.com	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	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	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: 47-72884388 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