Single 3 Amp Point-of-Load Switching Regulator

MHP8565A

Product Overview

Description

The MHP series are non-isolated point-of-load switching regulators for high reliability military and space distributed power applications (MIL-PRF-38534 certified facility). Fully integrated, these include a buck controller, inductor, and input/output capacitors combined in a single package. They operate from an input voltage of +4.5V to +12V, providing step down power conversion to output voltages as low as 0.5V or lower. Operating features include output voltage adjust, output current limit, and output enable/disable. Careful design and layout ensure excellent stability, transient response, and low noise operation. Packaged in a compact metal case, it operates over the full -55 °C to +125 °C temperature range.

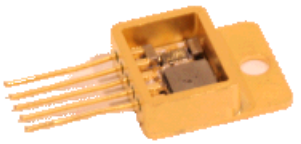
Features

- Now available as SMD: 5962R1323601xxx
- Single 3 amp product
- Efficiencies to 87%, see Figure 6-7
- Radiation hard to 100K rad TID
- Single-event results show no significant output transients through an LET of 58 MeV/(mg/cm^2).
- Optimized for 5V input. Consult factory for higher input voltages.
- Operates down to 4.5 volts input
- Current mode control
- Adjustable output voltage between 0.5V and 4V (depends on model, see Table 3-1)
- Enable function available
- Operates at a nominal frequency of 500 KHz

Applications/Benefits

- More efficient than competitive POLs (See Figure 6-6).
- FPGA power supply – satellite
- ASIC power supply – satellite

Figure 1. MO-078 (MHP8565)



Levels Available

COTS

Military

Space

Table of Contents

1. Absolute Maximum Ratings

Table 1-1. Absolute Maximum Ratings (Tc = +25 °C unless otherwise note)

Parameters / Test Conditions	Symbol	Value	Unit
Input voltage[1]	V_{in}	16	Vdc
Output current[2]	Io	4	A
Enable input voltage	V_{en}	7	Vdc
Approximate weight	MO-078	10	Grams
Operating temperature range, base of package	T_c	-55 to +125	°C
Storage temperature range	T_{stg}	-65 to +150	°C

Table 1-2. Thermal Characteristics

Parameters / Test Conditions	Symbol	Value	Unit
Series switch Thermal resistance, junction-to-case, MO-78 package	$R_{\theta JC}$	2.5	°C/W

Notes:

1. Most internal components are rated at +16 volts maximum and are therefore properly de-rated for operation at a nominal input of +5 volts. Operation at +12V will decrease that de-rating.
2. Internal series switch is self- protected and is rated to conduct 4.0 amps minimum. However, limitations on internal components plus the characteristics of PWM operation conspire to reduce further the minimum available output current, especially at output voltages above Vin/2. Minimum available output current is guaranteed to be as specified at output voltage of 2.5V down to 1.21V, assuming a clean layout. At output voltages below 1.21V, maximum output current may reduce by up to 1 amp, depending on actual output voltage, and load regulation may degrade slightly (up to 1%). At 3.3V output with a 5V input, output current reduces by 0.5A from the value specified at 2.5V out.

1.1 Mechanical Packaging

See Figure 6-1, Figure 6-2, Figure 6-3, Figure 6-4, and Table 6-1.

2. Electrical Characteristics

Table 2-1. Electrical Characteristics[1] (TA = -55 °C to +125 °C unless otherwise noted)

Parameters / Test Conditions	Symbol	Value			Unit
		Min.	Nom.	Max.	
Minimum input voltage[2]	Vin(min)	4.5	—	—	V
Output voltage accuracy Vo = 1.21V	Vout	1.19	—	1.23	V
Post 100K irradiation, 25 °C	Vout	1.17	—	1.24	V
Line regulation 4.5V < Vin < 5.5V Vo = 1.21V	Kvi	-0.5	—	+0.5	%
Load regulation 1A < Iout < 2A	Kvo	-1	—	+1	%
Current limit Vo = 2.5V	ICL	3.5	5	—	A
Post 100K irradiation, 25 °C		3.0	—	—	
Input voltage on enable pin to guarantee shutdown[3, 4] Io = 0A	Vshdn	0.13	0.40	0.60	V

Notes:

1. Testing is accomplished at an output load of 1A, and at an output voltage of 2.5V and an input of 5V unless otherwise specified. Only the specifications with post irradiation limits are tested after radiation exposure.
2. Minimum input voltage is guaranteed by line regulation test.
3. If not used, or when on, the enable pin should be pulled up to a logic one (2.5V min, 7V max) through a resistor of no more than 5K ohms. Voltage on this pin to disable operation needs to be less than 0.13V.
4. Not tested in production. Parameters are for reference only.

3. Model Number Functionality Chart

Table 3-1. Model Number Functionality Chart

Model Number[1]	Notes	Package Type	Output Type	Other Functionality					Former P/N
		MO-078	Adj	Enable Pin	Parallelable Note A	Output Voltage Range[2, 3]	Package Body	Internal Compensation	
MHP8565A**$&***	3 amp series	✓	✓	✓	No	0.5 - 4V	Isolated	✓	SAT8565A-3$T-ADJ

Replace "**$**" with letter to denote required screening level

- C = COTS
- M = MIL-PRF-38534, Class H
- S = MIL-PRF-38534, Class K

Replace "**&**" with lead lend option

- Blank = No lead-bend
- -1 = SMT lead-bend
- -2 = lead-bend down
- -3 = lead-bend up

Replace "*****" with lead finish option

- C = Gold plate
- A = Solder dipped

Notes:

1. See DSCC SMD 5962-13236 for DSCC part number options.
2. Internal series switch is self-protected and is rated to conduct 4.0 amps minimum. However, limitations on internal components plus the characteristics of PWM operation conspire to reduce further the minimum available output current, especially at output Voltages above Vin/2. Minimum available output current is guaranteed to be as specified at output voltage of 2.5V down to 1.21V, assuming a clean layout. At output voltages below 1.21V, maximum output current may reduce by up to 1 amp, depending on actual output voltage, and load regulation may degrade slightly (up to 1%). At 3.3V output with a 5V input, output current reduces by 0.5A from the value specified at 2.5V out.
3. Minimum input voltage is guaranteed by line regulation test.

Table 3-2. Example SMD Part Numbers

Standard Microcircuit Drawing	Microchip Similar Part[1]
5962R1323601KUC	MHP8565ASC
5962R1323601KUA	MHP8565ASA
5962R1323601KXC	MHP8565AS-1C
5962R1323601KXA	MHP8565AS-1A
5962R1323601KYC	MHP8565AS-2C
5962R1323601KYA	MHP8565AS-2A

.....continued

Standard Microcircuit Drawing	Microchip Similar Part[1]
5962R1323601KZC	MHP8565AS-3C
5962R1323601KZA	MHP8565AS-3A

The SMD number shown is for Class K screening and radiation hardness level R. See the SMD 13236 for the numbers for other screening and radiation levels. For exact specifications for an SMD product, refer to the SMD drawing. SMD's can be downloaded from the DLA Land and Maritime website.

Note:

1. Do not use the Microchip similar part number to order the SMD device.

4. Screening Options

Table 4-1. Screening Options

Test	Commercial	Military = Class H	Space = Class K	MIL-STD-883 Method
	COTS	MIL-PRF-38534		
Element evaluation	N/A	Military	Space	Note 1
Non-destruct wirebond pull	N/A	Sample	100%	2023
Pre-cap visual	N/A	100%	100%	2017
Temperature cycle	N/A	100%	100%	1010
Constant acceleration	N/A	100%	100%	2001
PIND	N/A	N/A	100%	2020
Pre-burn-in electrical	N/A	100%	100%	—
Burn-in	N/A	100% (160 hours)	100% (320 hours)	1015
Final electrical tests	100% (25 °C)	100%	100%	Note 1
Hermeticity (fine and gross leak)	100%	100%	100%	1014
X-ray[2]	N/A	N/A	Yes	2012
External visual	Sample	100%	100%	2009

NOTES:

1. Microchip is a DLA approved facility. Testing is performed per MIL-PRF-38534.
2. Maximum solder reflow temperature = 180 °C. Do not exceed.

5. Application Circuits, 3 Amp Product

Figure 5-1. 3A Adjustable Configuration

Vout = Vref x (1+Radj / 2490), with Vref ~ 1.21 Volts

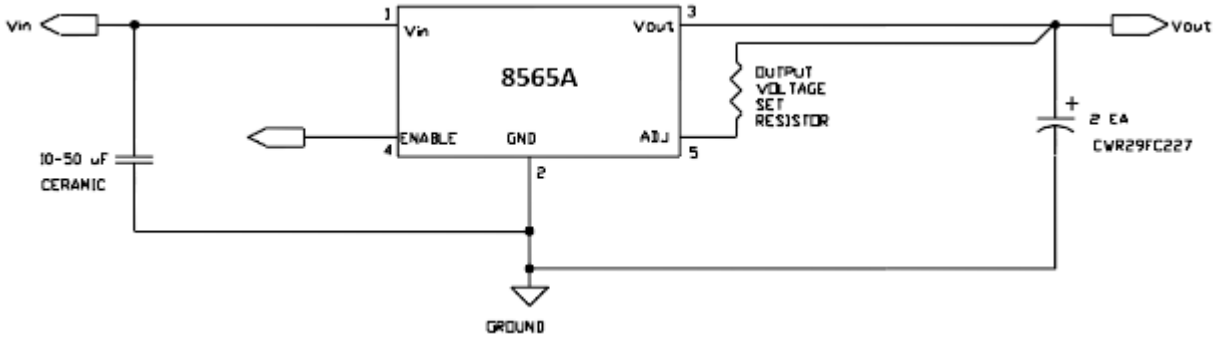
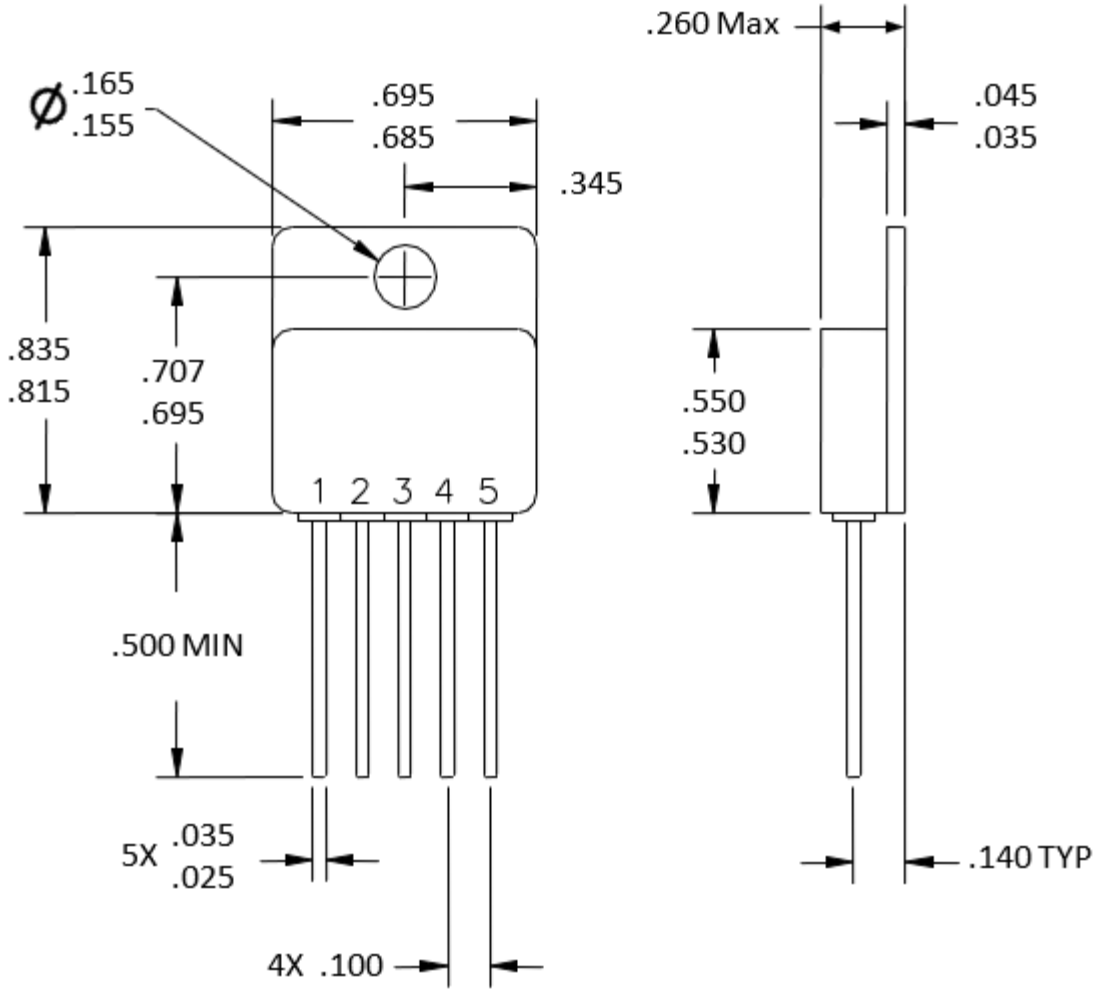


Table 5-1. Commonly Available 1% Resistor Values for Various Output Voltage for 3A Product

V_{out} (V)	R_{adj} (Ω)	V_{out} (V)	R_{adj} (Ω)
1.21	0	2.8	3240
1.5	590	3.0	3650
1.8	1210	3.3	4320
2.0	1620	3.5	4750
2.2	2050	3.8	5360
2.5	2670	4.0	5760

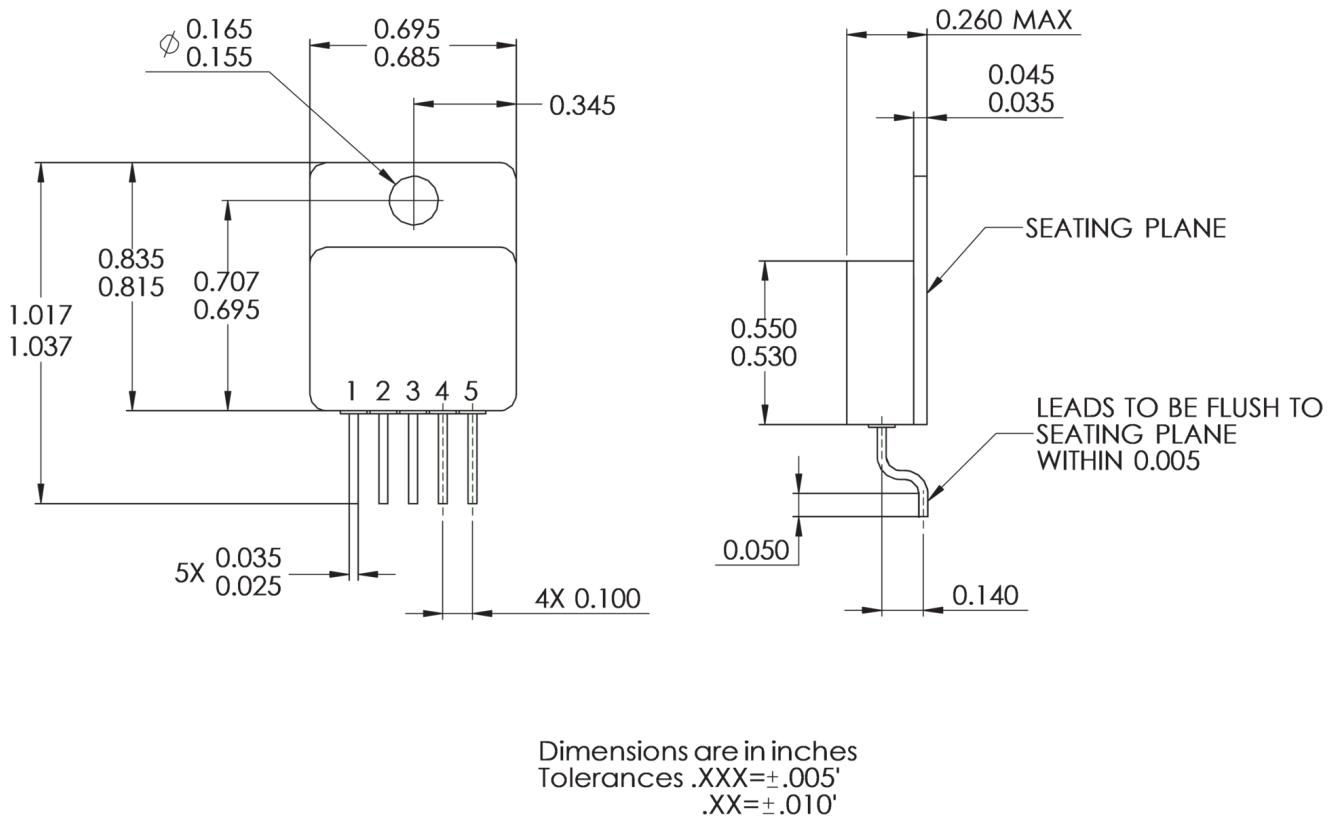
6. Package Outlines, 3 Amp Product (8565A)

Figure 6-1. Standard Straight Package



Dimensions are in inches
Tolerances .XXX = ± .005”
.XX = ± .010”

Figure 6-2. Surface Mount Lead-Bend (-1 Option)



Dimensions are in inches
Tolerances .XXX=±.005'
.XX=±.010'

Figure 6-3. Right Angle Lead-Bend (-2 Option Lead-Bend Down)

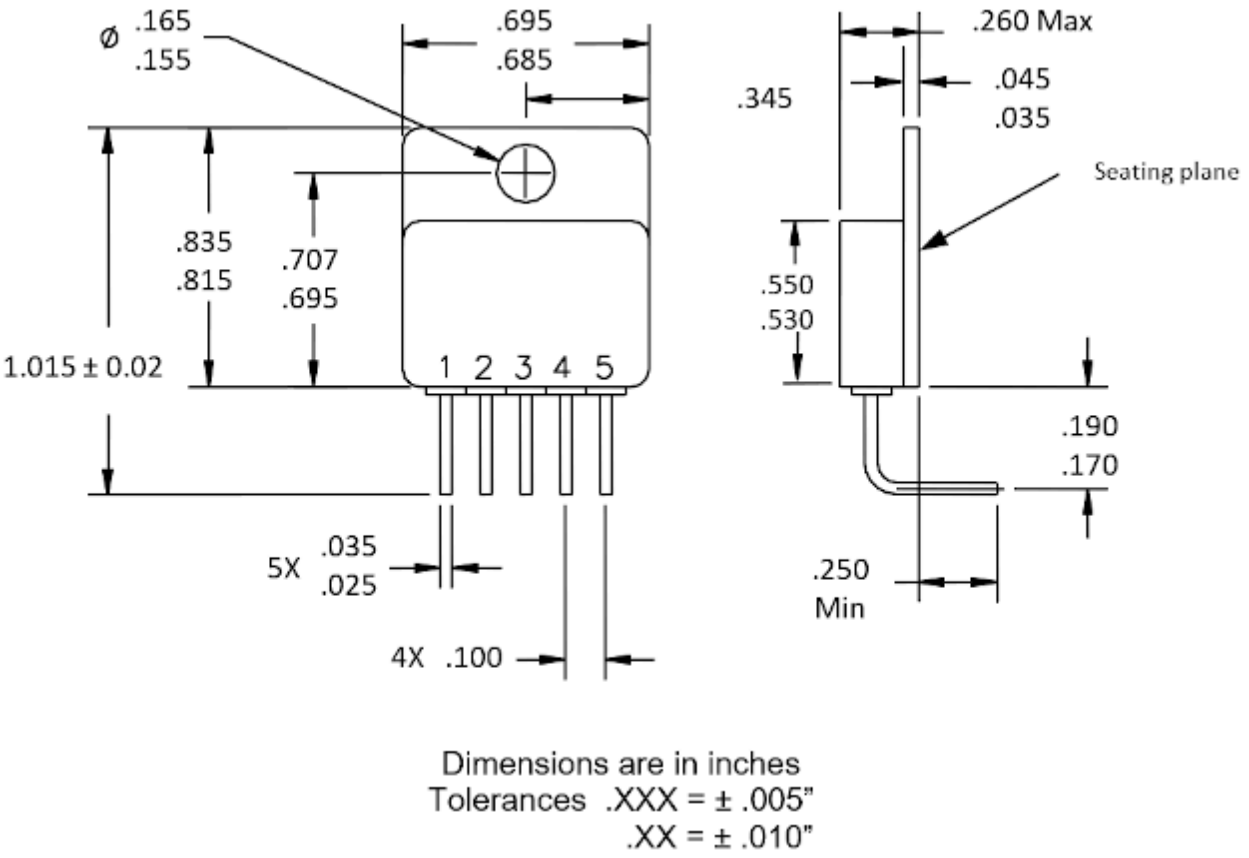


Figure 6-4. -3 Option Lead-Bend Up

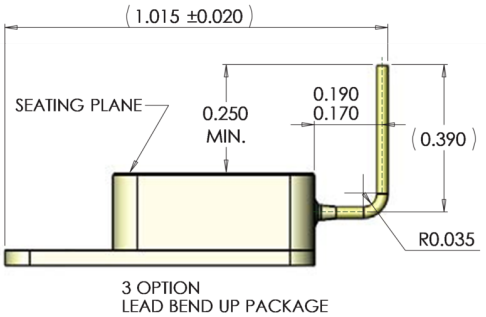


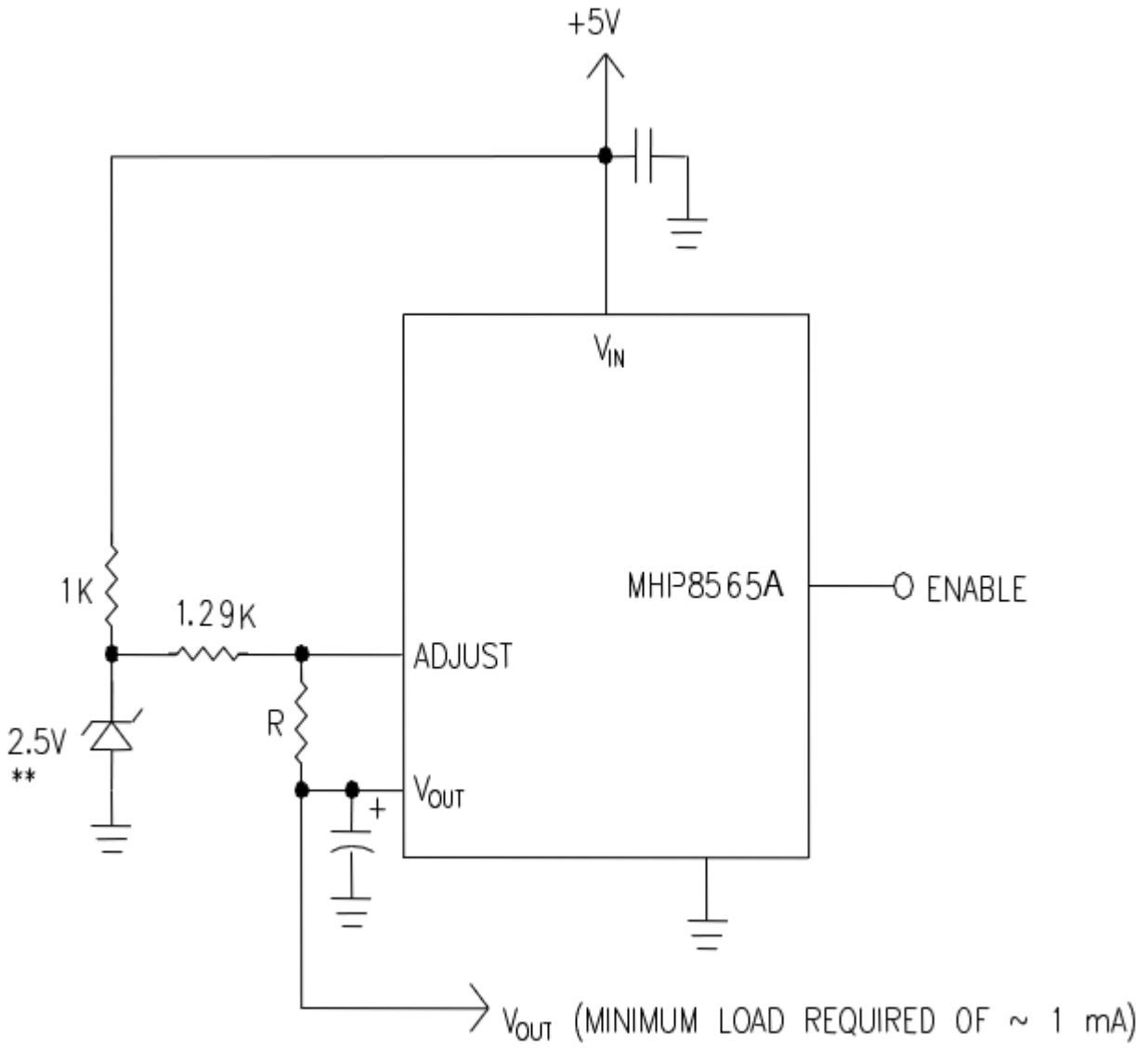
Table 6-1. Pin Assignments for 3 Amp Product

Pin No	8565A	
	Pin Name	Pin Description
1	Vin	Input voltage
2	GND	Current ground
3	Vout	Output voltage

.....continued

Pin No	8565A	
	Pin Name	Pin Description
4	Enable	Enable output
5	Adjust	Output voltage adjust
Case	N/C	Isolated

Figure 6-5. Circuit for Creating Regulated Output Voltages Below 1.21 Volts



Vout = 1.21 – R (K-Ohms)

Example: If R = 0.21K Ohms (210 Ohms), Vout = 1.21 – 0.21 = 1.0V, within the limits of the tolerances of the components used.

Note:
** RAD Hard Zener or other fixed voltage > 2V may be used. For any voltage other than 2.5V, resistor values would have to be adjusted accordingly.

Figure 6-6. MHP8565 Typical Efficiency Vs. Typical Competitive POL (Vin = 5V, Vout = 3.3V)

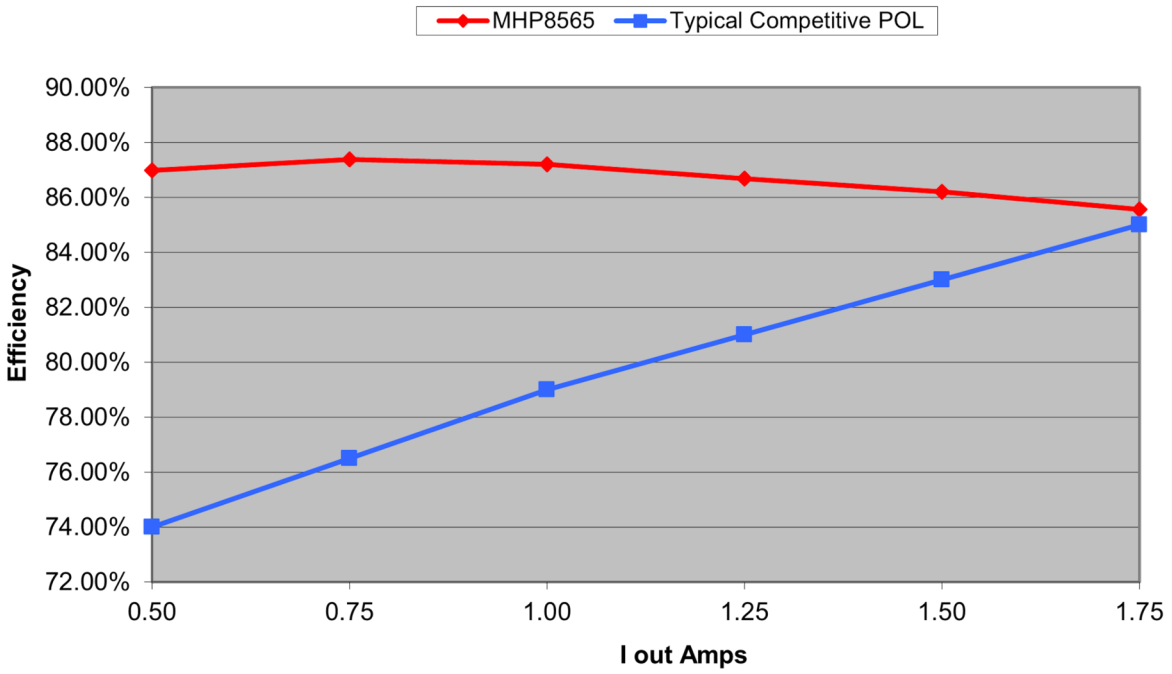
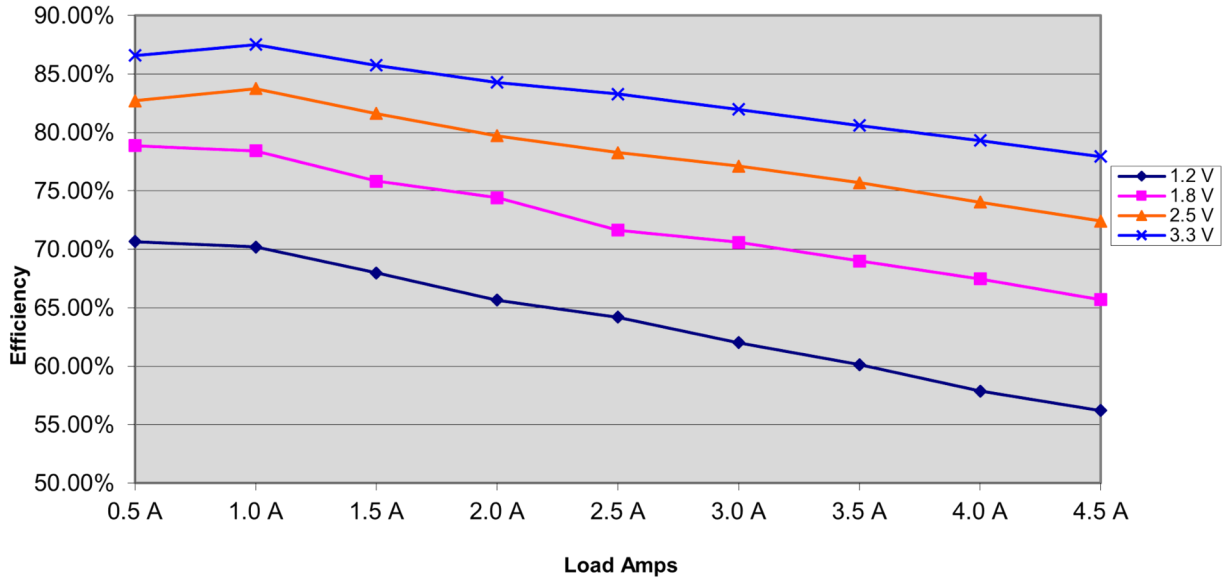


Figure 6-7. Typical Efficiency Curves (Vin = 5V)



7. Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

Revision	Date	Description
A	09/2023	Initial revision.

Microchip Information

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 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.

Legal Notice

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 www.microchip.com/en-us/support/design-help/client-support-services.

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, dsPIC, 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.

ISBN: 978-1-6683-3081-4

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	**Australia - Sydney**	**India - Bangalore**	**Austria - Wels**
2355 West Chandler Blvd.	Tel: 61-2-9868-6733	Tel: 91-80-3090-4444	Tel: 43-7242-2244-39
Chandler, AZ 85224-6199	**China - Beijing**	**India - New Delhi**	Fax: 43-7242-2244-393
Tel: 480-792-7200	Tel: 86-10-8569-7000	Tel: 91-11-4160-8631	**Denmark - Copenhagen**
Fax: 480-792-7277	**China - Chengdu**	**India - Pune**	Tel: 45-4485-5910
Technical Support:	Tel: 86-28-8665-5511	Tel: 91-20-4121-0141	Fax: 45-4485-2829
www.microchip.com/support	**China - Chongqing**	**Japan - Osaka**	**Finland - Espoo**
Web Address:	Tel: 86-23-8980-9588	Tel: 81-6-6152-7160	Tel: 358-9-4520-820
www.microchip.com	**China - Dongguan**	**Japan - Tokyo**	**France - Paris**
Atlanta	Tel: 86-769-8702-9880	Tel: 81-3-6880- 3770	Tel: 33-1-69-53-63-20
Duluth, GA	**China - Guangzhou**	**Korea - Daegu**	Fax: 33-1-69-30-90-79
Tel: 678-957-9614	Tel: 86-20-8755-8029	Tel: 82-53-744-4301	**Germany - Garching**
Fax: 678-957-1455	**China - Hangzhou**	**Korea - Seoul**	Tel: 49-8931-9700
Austin, TX	Tel: 86-571-8792-8115	Tel: 82-2-554-7200	**Germany - Haan**
Tel: 512-257-3370	**China - Hong Kong SAR**	**Malaysia - Kuala Lumpur**	Tel: 49-2129-3766400
Boston	Tel: 852-2943-5100	Tel: 60-3-7651-7906	**Germany - Heilbronn**
Westborough, MA	**China - Nanjing**	**Malaysia - Penang**	Tel: 49-7131-72400
Tel: 774-760-0087	Tel: 86-25-8473-2460	Tel: 60-4-227-8870	**Germany - Karlsruhe**
Fax: 774-760-0088	**China - Qingdao**	**Philippines - Manila**	Tel: 49-721-625370
Chicago	Tel: 86-532-8502-7355	Tel: 63-2-634-9065	**Germany - Munich**
Itasca, IL	**China - Shanghai**	**Singapore**	Tel: 49-89-627-144-0
Tel: 630-285-0071	Tel: 86-21-3326-8000	Tel: 65-6334-8870	Fax: 49-89-627-144-44
Fax: 630-285-0075	**China - Shenyang**	**Taiwan - Hsin Chu**	**Germany - Rosenheim**
Dallas	Tel: 86-24-2334-2829	Tel: 886-3-577-8366	Tel: 49-8031-354-560
Addison, TX	**China - Shenzhen**	**Taiwan - Kaohsiung**	**Israel - Ra'anana**
Tel: 972-818-7423	Tel: 86-755-8864-2200	Tel: 886-7-213-7830	Tel: 972-9-744-7705
Fax: 972-818-2924	**China - Suzhou**	**Taiwan - Taipei**	**Italy - Milan**
Detroit	Tel: 86-186-6233-1526	Tel: 886-2-2508-8600	Tel: 39-0331-742611
Novi, MI	**China - Wuhan**	**Thailand - Bangkok**	Fax: 39-0331-466781
Tel: 248-848-4000	Tel: 86-27-5980-5300	Tel: 66-2-694-1351	**Italy - Padova**
Houston, TX	**China - Xian**	**Vietnam - Ho Chi Minh**	Tel: 39-049-7625286
Tel: 281-894-5983	Tel: 86-29-8833-7252	Tel: 84-28-5448-2100	**Netherlands - Drunen**
Indianapolis	**China - Xiamen**		Tel: 31-416-690399
Noblesville, IN	Tel: 86-592-2388138		Fax: 31-416-690340
Tel: 317-773-8323	**China - Zhuhai**		**Norway - Trondheim**
Fax: 317-773-5453	Tel: 86-756-3210040		Tel: 47-72884388
Tel: 317-536-2380			**Poland - Warsaw**
Los Angeles			Tel: 48-22-3325737
Mission Viejo, CA			**Romania - Bucharest**
Tel: 949-462-9523			Tel: 40-21-407-87-50
Fax: 949-462-9608			**Spain - Madrid**
Tel: 951-273-7800			Tel: 34-91-708-08-90
Raleigh, NC			Fax: 34-91-708-08-91
Tel: 919-844-7510			**Sweden - Gothenberg**
New York, NY			Tel: 46-31-704-60-40
Tel: 631-435-6000			**Sweden - Stockholm**
San Jose, CA			Tel: 46-8-5090-4654
Tel: 408-735-9110			**UK - Wokingham**
Tel: 408-436-4270			Tel: 44-118-921-5800
Canada - Toronto			Fax: 44-118-921-5820
Tel: 905-695-1980			
Fax: 905-695-2078			