3.0A Low-Dropout Linear Regulator with Programmable Soft-Start

FEATURES

- **3.0A LDO Regulator with Programmable Soft-Start (SS)**
- **SS Pin Provides a Linear Startup with Ramp Time Set by External Capacitor**
- **Supports Input Voltages as Low as 0.9V**
- **Adjustable Output (0.8V to 3.3V)**
- **Ultra-Low Dropout: 120mV at 3.0A (typ)**
- **1% Accuracy Over Line, Load, and Temperature**
- **Stable with Any or No Output Capacitor**
- **Active High Enable**
- **Open-Drain Power-Good (5 × 5 QFN)**
- **Available in 5mm × 5mm × 1mm QFN and DDPAK-7 Packages**
- **External BIAS Permits Low V_{IN} Operation with Excellent Transient Response**

APPLICATIONS

- **FPGA Applications**
- **DSP Core and I/O Voltages**
- **Post-Regulation Applications**
- **Applications with Special Start-up time Requirements**

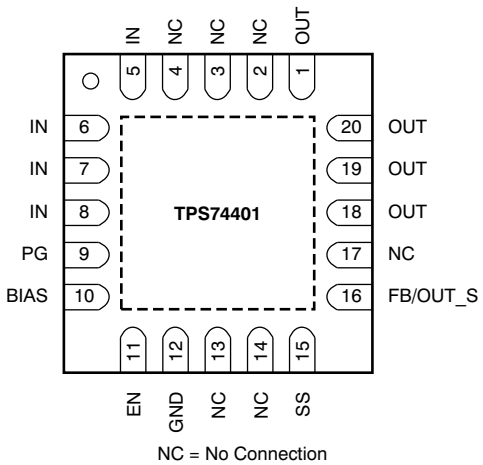
DESCRIPTION

The TPS74401 low dropout (LDO) linear regulator provides an easy-to-use power management solution for many high-current applications. The user-programmed soft-start (SS) input limits inrush current in FPGAs and DSPs. The enable input (EN) and power-good (PG) outputs allow easy sequencing with external regulators. This complete flexibility permits the user to configure a solution that will meet the sequencing requirements of FPGAs, DSPs, and other applications with special startup requirements.

A precision reference and error amplifier deliver 1% accuracy over load, line, temperature, and process. The LDO regulator is stable with any or no output capacitor and is fully specified from –40°C to +125°C. The TPS74401 is offered in a small 5mm × 5mm QFN package, yielding a highly compact total solution size. For applications that require additional power dissipation, the DDPAK (KTW) package is also available.

PRODUCT PREVIEW

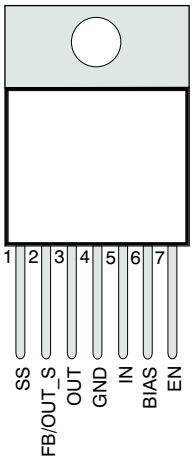
RGW Package
5 x 5 QFN
(Top View)



NC = No Connection

Actual Size

KTW Package
DDPAK-7
(Top View)



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

ORDERING INFORMATION(1)

PRODUCT	V_{OUT}(2)	PACKAGE-LEAD	ORDERING NUMBER
TPS74401	Adjustable	5 × 5 QFN(3)	TPS74401RGWT
			TPS74401RGWR
TPS74401	Adjustable	DDPAK-7(4)	TPS74401KTWT
			TPS74401KTWR

(1) For the most current package and ordering information see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Other output voltages are available, minimum order quantities may apply. See available output voltage options table for details; contact factory for availability.
(3) The **T** suffix indicates 250-piece tape and reel; the **R** suffix indicates 3000-piece tape and reel quantities.
(4) The **T** suffix indicates 50-piece tape and reel; the **R** suffix indicates 500-piece tape and reel quantities.

PRODUCT PREVIEW

ABSOLUTE MAXIMUM RATINGS(1)

At T_A = –40°C to +125°C, unless otherwise noted. All voltages are with respect to GND.

		TPS74401	UNIT
V_{IN}, V_{BIAS}	Input voltage range	–0.3 to +6	V
V_{EN}	Enable voltage range	–0.3 to +6 or V_{IN} + 0.3, whichever is greater	V
V_{PG}	Power-good voltage range	–0.3 to +6	V
V_{OUT}	Output voltage range	–0.3 to V_{IN}	V
I_{OUT}	Maximum output current	Internally limited	
Output short circuit duration		Indefinite	
P_{DISS}	Continuous total power dissipation	See Dissipation Ratings	
T_J	Operating junction temperature range	–40 to +150	°C
T_{STG}	Storage junction temperature range	–55 to +150	°C
ESD rating, HBM		2	kV
ESD rating, CDM		500	V

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

DISSIPATION RATINGS

PACKAGE	θ_{JA}	θ_{JC}	T_A < +25°C POWER RATING	DERATING FACTOR ABOVE T_A = +25°C
RGW (QFN)	31.4°C/W	1.25°C/W	3.183W	0.0318W/°C
KTW (DDPAK)	TBD	TBD	TBD	TBD

ELECTRICAL CHARACTERISTICS

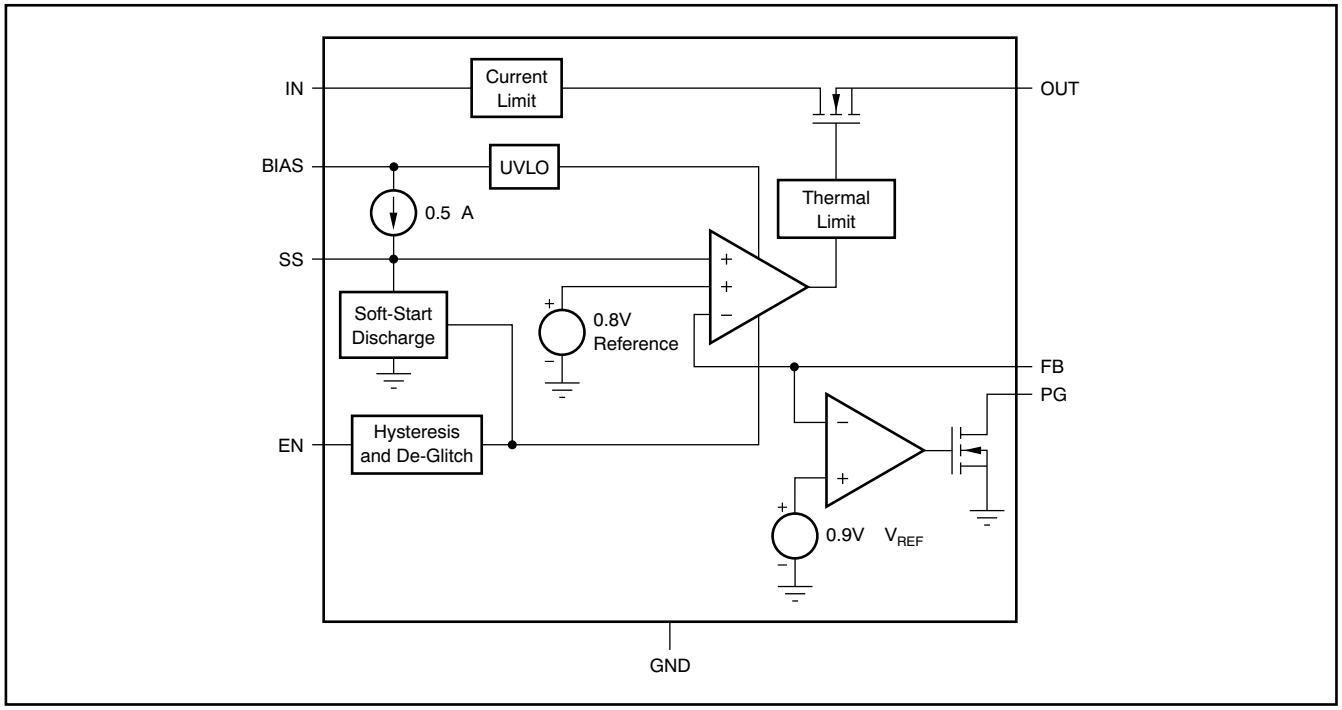
At T_A = +25°C, V_{EN} = 1.1V, V_{IN} = V_{OUT} + 0.3V, C_{IN} = C_{BIAS} = 0.1µF, C_{OUT} = 10µF, I_{OUT} = 50mA, V_{BIAS} = 3.3V, and T_J = –40°C to +125°C, unless otherwise noted.

PARAMETER		TEST CONDITIONS	TPS74401			UNIT
			MIN	TYP	MAX	
V_{IN}	Input Voltage Range		$V_{OUT\ (NOM)}$ + $V_{DO\ (MAX)}$		5.5	V
V_{REF}	Internal Reference (Adj.)		0.796	0.8	0.804	V
V_{BIAS}	Bias Pin Voltage Range(1)		2.375		5.5	V
V_{OUT}	Output Voltage Range	V_{IN} = V_{OUT} + 1V, I_{OUT} = 1.5A, V_{BIAS} = 5V	V_{REF}		3.3	V
	Accuracy	Nominal, T_J = +25°C	–0.5		+0.5	%
		2.97V ≤ V_{BIAS} ≤ 5.5V, 50mA ≤ I_{OUT} ≤ 3.0A	–1	±0.5	1	
V_{OUT}/V_{IN}	Line Regulation	$V_{OUT\ (NOM)}$ + 0.3 < V_{IN} < 5.5V		TBD	TBD	%/V
V_{OUT}/I_{OUT}	Load Regulation	50mA ≤ I_{OUT} ≤ 3.0A		TBD	TBD	%/A
V_{DO}	Dropout Voltage (External Bias)	I_{OUT} = 3.0A, V_{BIAS} – $V_{OUT\ (NOM)}$ ≥ 1.62V, QFN		120	200	mV
		I_{OUT} = 3.0A, V_{BIAS} – $V_{OUT\ (NOM)}$ ≥ 1.62V, DDPAK		150	240	mV
	Dropout Voltage (V_{IN} = V_{BIAS})	I_{OUT} = 3.0A			1.6	V
I_{BIAS}	Bias Pin Current	I_{OUT} = 0mA to 3.0A		3	5	mA
I_{SHDN}	Shutdown Supply Current (IN)	V_{EN} ≤ 0.4V, T_J = –40°C to +85°C		50	100	µA
I_{CL1}	Current Limit	V_{OUT} = 90% × $V_{OUT\ (NOM)}$	4.1		5.5	A
I_{FB}	Feedback Pin Current			10	200	nA
PSRR	Power-Supply Rejection (V_{IN} to V_{OUT})	1kHz, I_{OUT} = 3.0A, V_{IN} = 1.8V, V_{OUT} = 1.5V, V_{BIAS} = 3.3V, C_{OUT} = 10µF		60		dB
		300kHz, I_{OUT} = 3.0A, V_{IN} = 1.8V, V_{OUT} = 1.5V, V_{BIAS} = 3.3V, C_{OUT} = 10µF		30		
	Power-Supply Rejection (V_{BIAS} to V_{OUT})	1kHz, I_{OUT} = 3.0A, V_{IN} = 1.8V, V_{OUT} = 1.5V, V_{BIAS} = 3.3V, C_{OUT} = 10µF		50		dB
		300kHz, I_{OUT} = 3.0A, V_{IN} = 1.8V, V_{OUT} = 1.5V, V_{BIAS} = 3.3V, C_{OUT} = 10µF		30		
Noise	Output Noise Voltage	100Hz to 100kHz, I_{OUT} = 3.0A, C_{SS} = 0.001µF		25 × V_{OUT}		μV_{RMS}
t_{STR}	Minimum Startup Time	I_{OUT} = 3.0A, C_{SS} = Open		100		µs
I_{SS}	Soft-Start Charging Current	V_{SS} = 0.4V	0.3	0.5	1	µA
$V_{EN,\ HI}$	Enable Input High Level		1.1		V_{BIAS}	V
$V_{EN,\ LO}$	Enable Input Low Level		0		0.4	V
V_{ENHYS}	Enable Pin Hysteresis			50		mV
V_{ENDG}	Enable Pin De-Glitch Time			20		µs
I_{EN}	Enable Pin Current	V_{EN} = 5V		0.1	1.0	µA
V_{IT}	PG Trip Threshold	V_{OUT} Decreasing	88	90	92	$\%V_{OUT}$
V_{HYS}	PG Trip Hysteresis			3		$\%V_{OUT}$
$V_{PG,\ LO}$	PG Output Low Voltage	I_{PG} = 1mA (sinking), V_{OUT} < V_{IT}, 2.375V ≤ V_{BIAS}≤ 5.5V			0.3	V
$I_{PG,\ LKG}$	PG Leakage Current	V_{PG} = 5V, V_{OUT} > V_{IT}		0.1	1.0	µA
T_J	Operating Junction Temperature		–40		+125	°C
T_{SD}	Thermal Shutdown Temperature	Shutdown, Temperature Increasing		+165		°C
		Reset, Temperature Decreasing		+140		

(1) Minimum V_{BIAS} = 2.375V or V_{OUT} + V_{DO}, whichever is greater.

PRODUCT PREVIEW

BLOCK DIAGRAM



PIN DESCRIPTIONS

NAME	KTW (DDPAK)	RGW (QFN)	DESCRIPTION
IN	5	5-8	Unregulated input to the device.
EN	7	11	Enable pin. Driving this pin high enables the regulator. Driving this pin low puts the regulator into shutdown mode.
SS	1	15	Soft-Start pin. A capacitor connected on this pin to ground will set the startup time.
BIAS	6	10	Bias voltage for error amplifier, reference, and internal control circuits.
PG	NA	9	Power-Good (PG) is an open-drain, active-high output that indicates the status of V_{OUT}. When V_{OUT} exceeds the PG trip threshold, the PG pin goes into a high-impedance state. When V_{OUT} is below this threshold the pin is driven to a low-impedance state. A pull-up resistor from 10kΩ to 1MΩ should be used on this pin, which would allow the PG output to attain voltages higher than V_{IN}.
FB	2	16	This pin is the feedback connection to an external resistor divider network that sets the output voltage.
OUT	3	1, 18-20	Regulated output voltage.
NC	NA	2-4, 13, 14, 17	No connection. This pin can be left floating or connected to GND to allow better thermal contact to the top-side plane.
PAD/TAB			Electrically isolated. Should be soldered to ground plane for heat sinking.

PACKAGING INFORMATION

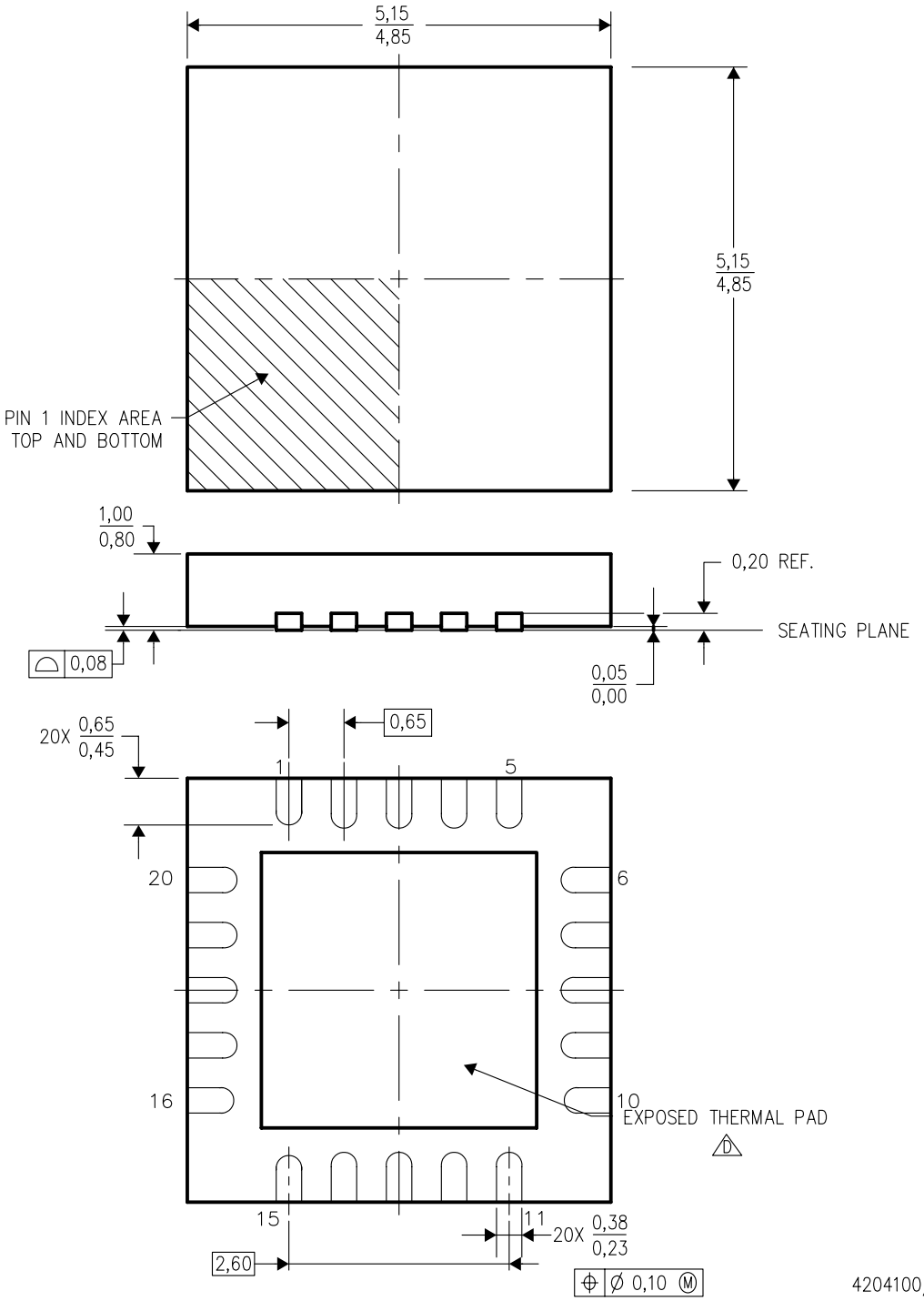
Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TPS74401KTWR	PREVIEW	DDPAK	KTW	7		TBD	Call TI	Call TI
TPS74401KTWT	PREVIEW	DDPAK	KTW	7		TBD	Call TI	Call TI
TPS74401RGWR	PREVIEW	QFN	RGW	20		TBD	Call TI	Call TI
TPS74401RGWT	PREVIEW	QFN	RGW	20		TBD	Call TI	Call TI

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

RGW (S–PQFP–N20) PLASTIC QUAD FLATPACK



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5–1994.
B. This drawing is subject to change without notice.
C. Quad Flat pack, No–leads (QFN) package configuration
D. The package thermal pad must be soldered to the board for thermal and mechanical performance.. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.
E. Falls within JEDEC MO–220.

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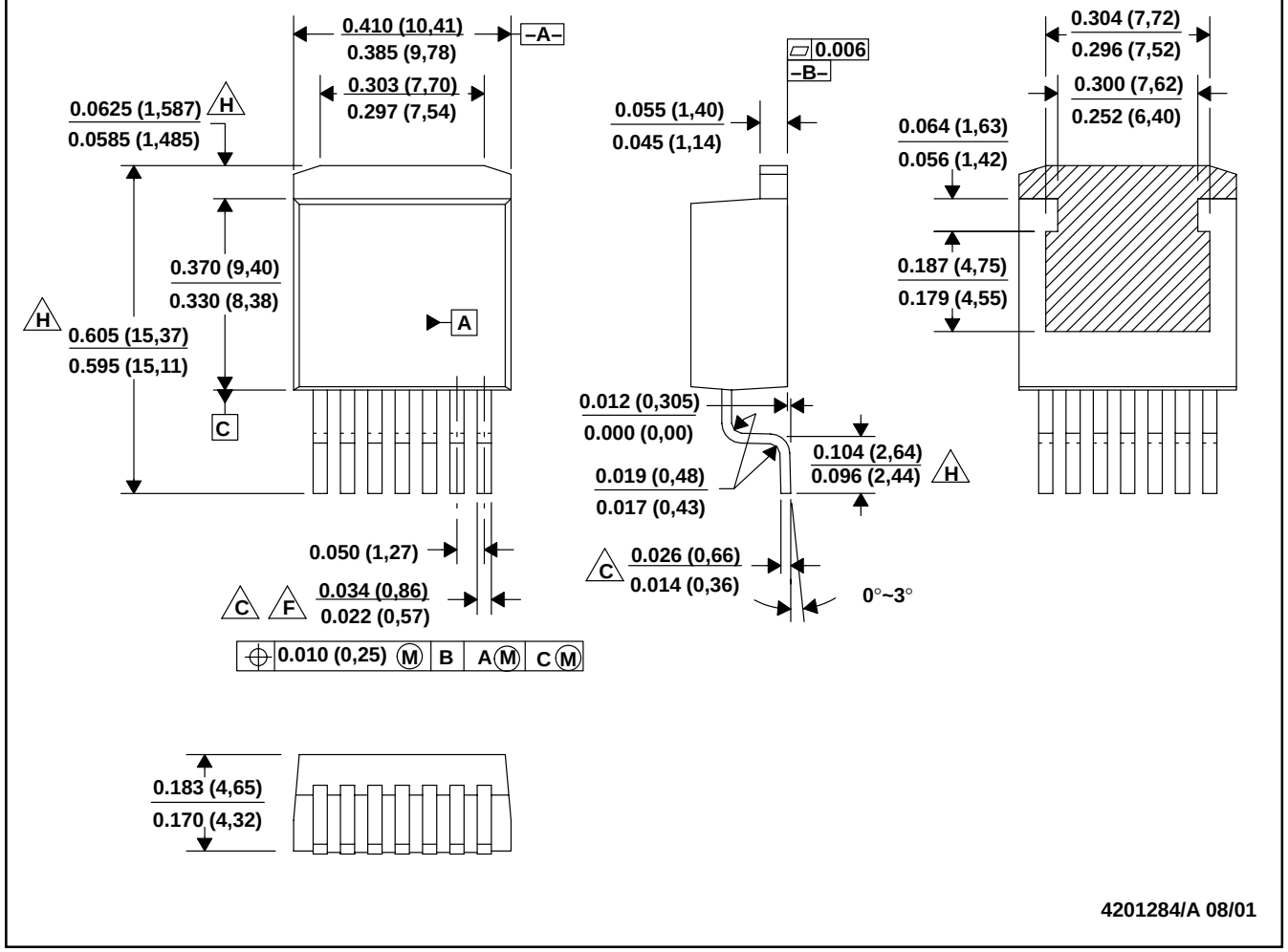
KTW (R-PSFM-G7) **PLASTIC FLANGE-MOUNT**



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Lead width and height dimensions apply to the plated lead.
D. Leads are not allowed above the Datum B.
E. Stand–off height is measured from lead tip with reference to Datum B.
F. Lead width dimension does not include dambar protrusion. Allowable dambar protrusion shall not cause the lead width to exceed the maximum dimension by more than 0.003”.
G. Cross–hatch indicates exposed metal surface.
H. Falls within JEDEC MO–169 with the exception of the dimensions indicated.

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