



**THE DATASHEET OF
TMP300BQDCKRQ1**



1.8V, Resistor-Programmable TEMPERATURE SWITCH and ANALOG OUT TEMPERATURE SENSOR in SC70

Check for Samples: [TMP300B-Q1](#)

FEATURES

- **ACCURACY:** $\pm 1^{\circ}\text{C}$ (typical at $+25^{\circ}\text{C}$)
- **PROGRAMMABLE TRIP POINT**
- **PROGRAMMABLE HYSTERESIS:** $5^{\circ}\text{C}/10^{\circ}\text{C}$
- **OPEN-DRAIN OUTPUTS**
- **LOW-POWER:** $110\mu\text{A}$ (max)
- **WIDE VOLTAGE RANGE:** $+1.8\text{V}$ to $+18\text{V}$
- **OPERATION:** -40°C to $+150^{\circ}\text{C}$
- **ANALOG OUT:** $10\text{mV}/^{\circ}\text{C}$
- **SC70-6 PACKAGE**

APPLICATIONS

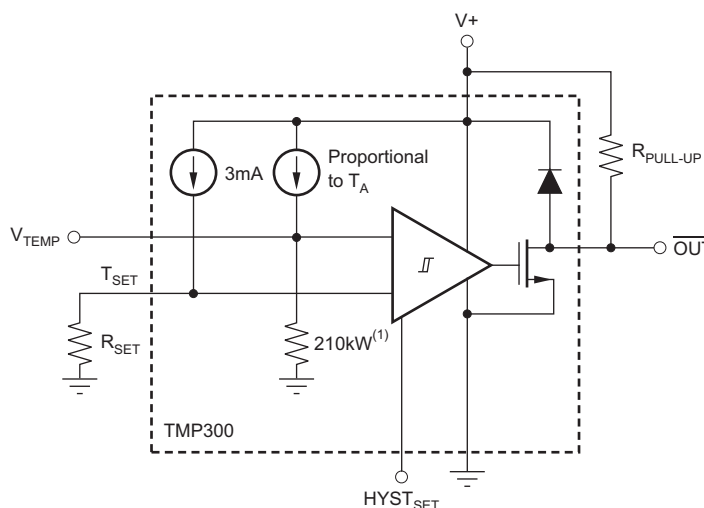
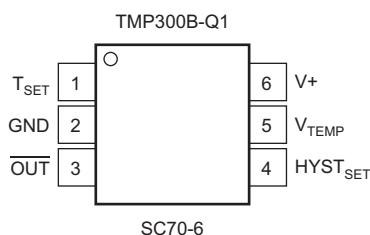
- **QUALIFIED FOR** for **AUTOMOTIVE APPLICATIONS**
- **POWER-SUPPLY SYSTEMS**
- **DC-DC MODULES**
- **THERMAL MONITORING**
- **ELECTRONIC PROTECTION SYSTEMS**

DESCRIPTION

The TMP300B-Q1 is a low-power, resistor-programmable, digital output temperature switch. It allows a threshold point to be set by adding an external resistor. Two levels of hysteresis are available. The TMP300B-Q1 has a V_{TEMP} analog output that can be used as a testing point or in temperature-compensation loops.

With a supply voltage as low as 1.8V and low current consumption, the TMP300B-Q1 is ideal for power-sensitive systems.

Available in two micropackages that have proven thermal characteristics, this part gives a complete and simple solution for users who need simple and reliable thermal management.



NOTE: (1) Thinfilm resistor with approximately 10% accuracy; however, this accuracy error is trimmed out at the factory.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.



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⁾

ORDERABLE P/N	T _A	PACKAGE	TOP SIDE SYMBOL
TMP300BQDCKRQ1 or TMP300B-Q1	-40°C to 125°C	SC70 - DCK Reel of 3000	SBG

(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.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

		VALUE	UNIT
Supply Voltage	V+	+18	V
Signal Input Terminals, Voltage ⁽²⁾		-0.5 to (V+) + 0.5	V
Signal Input Terminals, Current ⁽²⁾		±10	mA
Output Short-Circuit ⁽³⁾	I _{sc}	Continuous	
Open-Drain Output		(V+) + 0.5	V
Operating Temperature	T _A	-40 to +150	°C
Storage Temperature	T _A	-55 to +150	°C
Junction Temperature	T _J	+150	°C
ESD Rating	Human Body Model (HBM)	4000	V
	Charged Device Model (CDM)	1000	V
	Machine Model (MM)	200	V

- (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not supported.
- (2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current limited to 10mA or less.
- (3) Short-circuit to ground.

ELECTRICAL CHARACTERISTICS

At $V_S = 3.3V$ and $T_A = -40^{\circ}C$ to $+125^{\circ}C$, unless otherwise noted.

PARAMETER	TEST CONDITIONS	TMP300B-Q1			UNIT	
		MIN	TYP	MAX		
TEMPERATURE MEASUREMENT						
Measurement Range	$V_S = 2.35V$ to $18V$	-40		+125	$^{\circ}C$	
	$V_S = 1.8V$ to $2.35V$	-40		$100 \times (V_S - 0.95)$	$^{\circ}C$	
TRIP POINT						
Total Accuracy	$T_A = -40^{\circ}C$ to $+125^{\circ}C$		± 2	± 6	$^{\circ}C$	
R_{SET} Equation	T_C is in $^{\circ}C$	$R_{SET} = 10 (50 + T_C)/3$			$k\Omega$	
HYSTERESIS SET INPUT						
LOW Threshold ⁽¹⁾				0.4	V	
HIGH Threshold ⁽¹⁾		$V_S - 0.4$			V	
Threshold Hysteresis	$HYST_{SET} = GND$		5		$^{\circ}C$	
	$HYST_{SET} = V_S$		10		$^{\circ}C$	
DIGITAL OUTPUT						
Logic Family			CMOS			
Open-Drain Leakage Current ⁽¹⁾	$OUT = V_S$			10	μA	
Logic Levels						
V_{OL}	$V_S = 1.8V$ to $18V$, $I_{SINK} = 5mA$			0.3	V	
ANALOG OUTPUT						
Accuracy			± 2	± 5	$^{\circ}C$	
Temperature Sensitivity			10		$mV/^{\circ}C$	
Output Voltage ⁽¹⁾	$T_A = +25^{\circ}C$	720	750	780	mV	
V_{TEMP} Pin Output Resistance			210		$k\Omega$	
POWER SUPPLY						
Quiescent Current ⁽²⁾	I_Q , $V_S = 1.8V$ to $18V$, $T_A = -40^{\circ}C$ to $+125^{\circ}C$			110	μA	
TEMPERATURE RANGE						
Specified Range	T_A	$V_S = 2.35V$ to $18V$	-40		+125	$^{\circ}C$
		$V_S = 1.8V$ to $2.35V$	-40		$100 \times (V_S - 0.95)$	$^{\circ}C$
Operating Range	T_A	$V_S = 2.35V$ to $18V$	-40		+150	$^{\circ}C$
		$V_S = 1.8V$ to $2.35V$	-50		$100 \times (V_S - 0.95)$	$^{\circ}C$
Thermal Resistance	θ_{JA}					
SC70				250	$^{\circ}C/W$	
SOT23-6				180	$^{\circ}C/W$	

(1) Specified by design. Not production tested.

(2) See [Figure 1](#) for typical quiescent current.

TYPICAL CHARACTERISTICS

At $V_S = 5V$, unless otherwise noted.

QUIESCENT CURRENT OVER TEMPERATURE AND SUPPLY

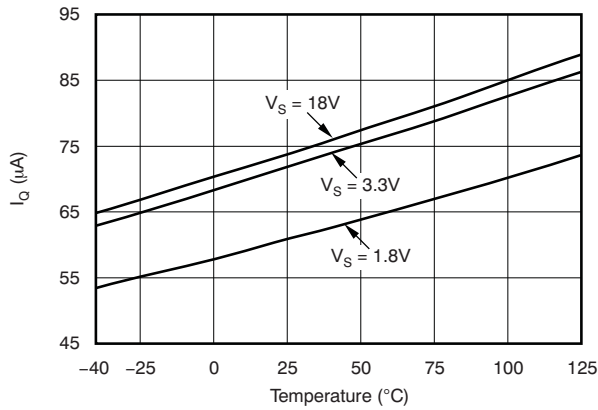


Figure 1.

R_{SET} SHIFT DUE TO R_{SET} TOLERANCE

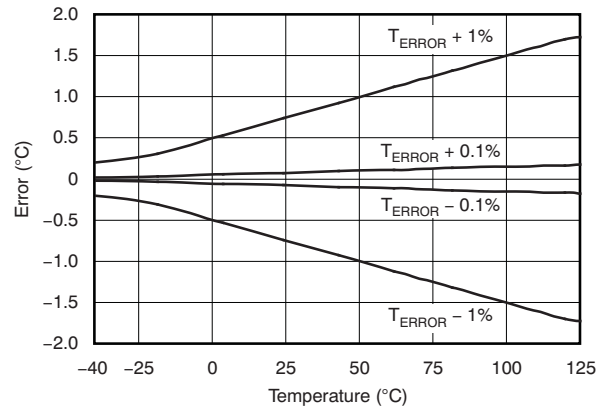


Figure 2.

R_{SET} VS TEMPERATURE

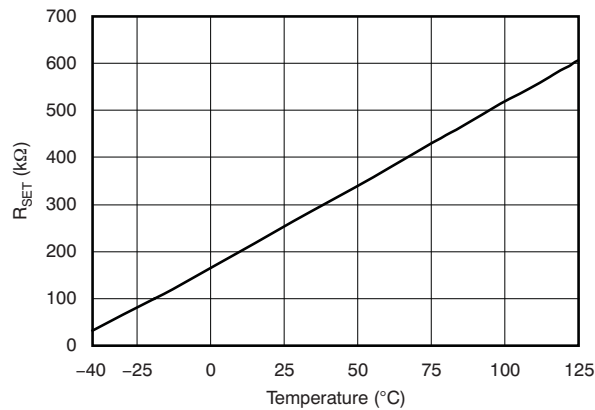


Figure 3.

TYPICAL TRIP ERROR

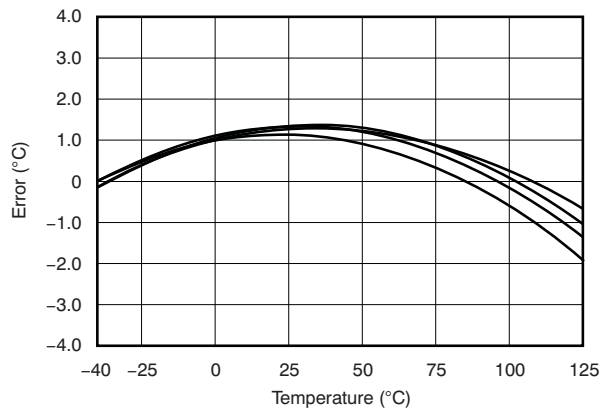


Figure 4.

TYPICAL ANALOG OUTPUT ERROR

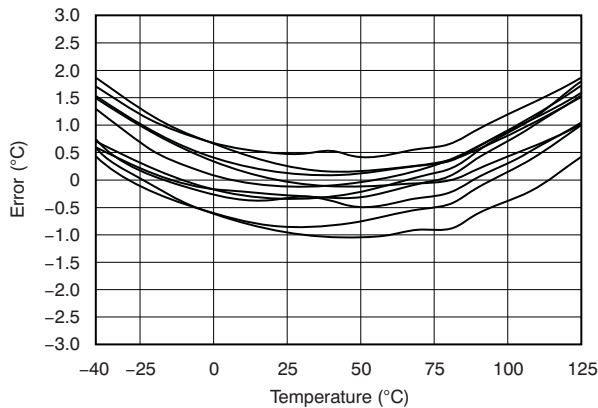


Figure 5.

ANALOG PSR OVER TEMPERATURE

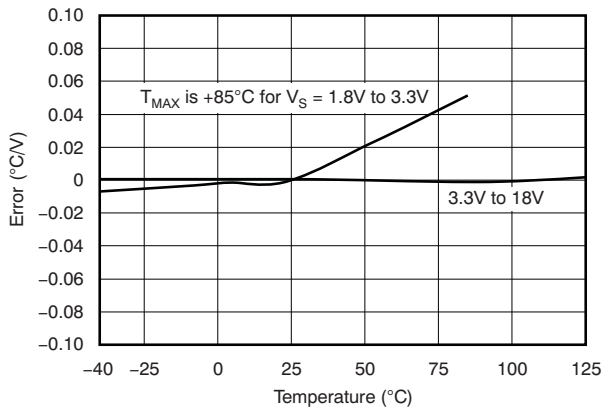
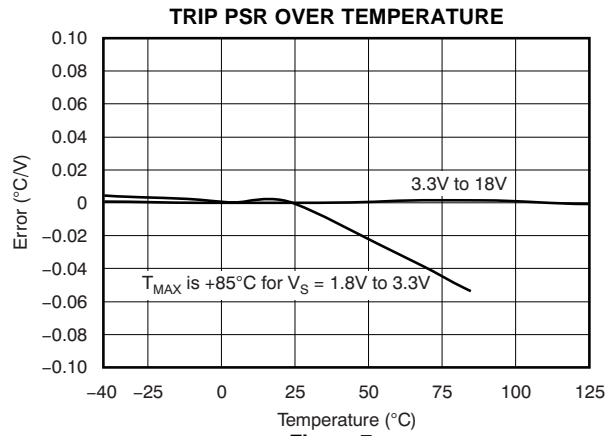


Figure 6.

TYPICAL CHARACTERISTICS (continued)

At $V_S = 5V$, unless otherwise noted.



APPLICATIONS INFORMATION

The TMP300B-Q1 is a thermal sensor designed for over-temperature protection circuits in electronic systems. The TMP300B-Q1 uses a set resistor to program the trip temperature of the digital output. An additional high-impedance (210kΩ) analog voltage output provides the temperature reading.

CALCULATING R_{SET}

The set resistor (R_{SET}) provides a threshold voltage for the comparator input. The TMP300B-Q1 trips when the V_{TEMP} pin exceeds the T_{SET} voltage. The value of the set resistor is determined by the analog output function and the 3μA internal bias current.

To set the TMP300B-Q1 to trip at a preset value, calculate the R_{SET} resistor value according to [Equation 1](#) or [Equation 2](#):

$$R_{SET} = \frac{(T_{SET} \times 0.01 + 0.5)}{3e^{-6}} \tag{1}$$

Where T_{SET} is in °C; or

$$R_{SET} \text{ in } k\Omega = \frac{10(50 + T_{SET})}{3} \tag{2}$$

Where T_{SET} is in °C.

USING V_{TEMP} TO TRIP THE DIGITAL OUTPUT

The analog voltage output can also serve as a voltage input that forces a trip of the digital output to simulate a thermal event. This simulation facilitates easy system design and test of thermal safety circuits, as shown in [Figure 8](#).

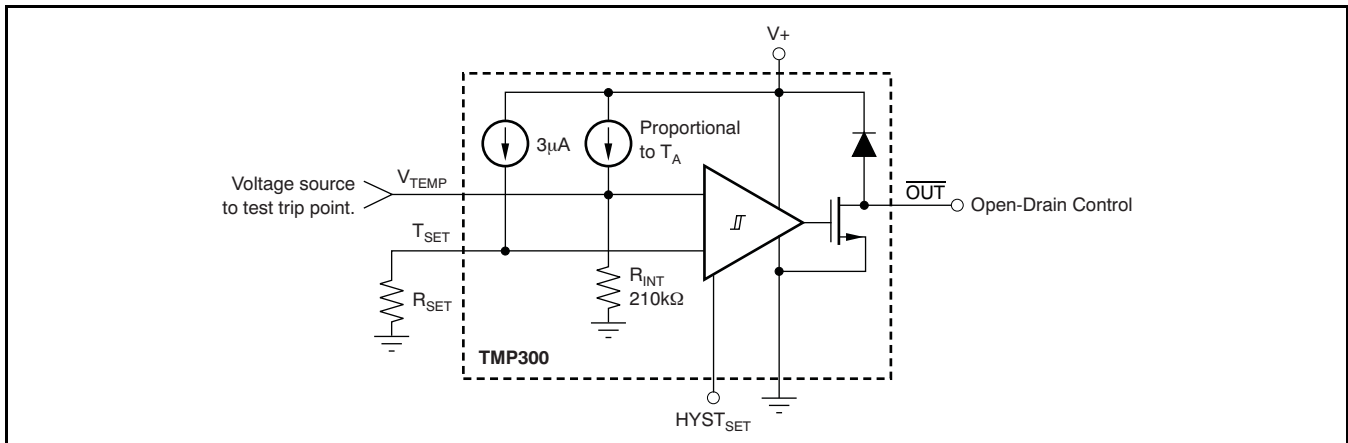


Figure 8. Applying Voltage to Trip Digital Output

ANALOG TEMPERATURE OUTPUT

The analog out or V_{TEMP} pin is high-impedance (210k Ω). Avoid loading this pin to prevent degrading the analog out value or trip point. Buffer the output of this pin when using it for direct thermal measurement. Figure 9 shows buffering of the analog output signal.

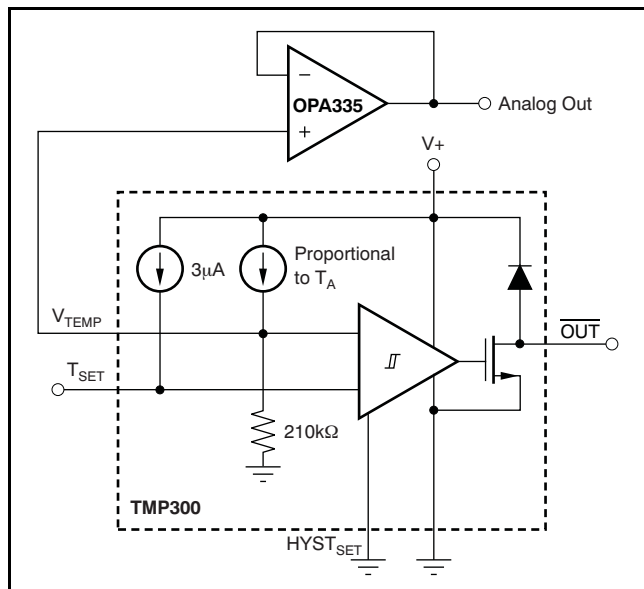


Figure 9. Buffering the Analog Output Signal

USING A DAC TO SET THE TRIP POINT

The trip point is easily converted by changing the digital-to-analog converter (DAC) code. This technique can be useful for control loops where a large thermal mass is being brought up to the set temperature and the \overline{OUT} pin is used to control the heating element. The analog output can be monitored in a control algorithm that adjusts the set temperature to prevent overshoot. Trip set voltage error versus temperature is shown in Figure 10, which shows error in $^{\circ}\text{C}$ of the comparator input over temperature. An alternative method of setting the trip point by using a DAC is shown in Figure 11.

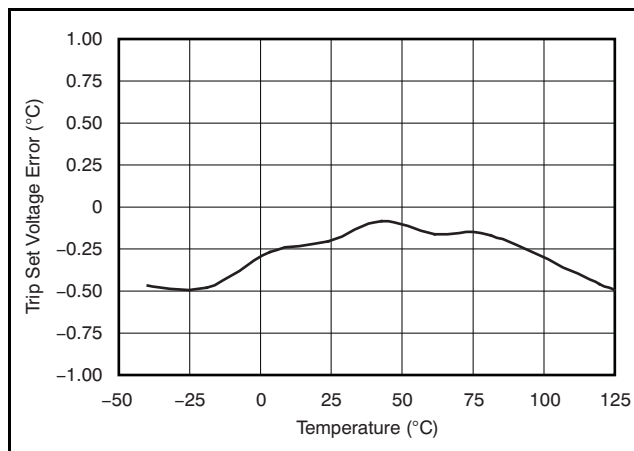


Figure 10. Trip Set Voltage Error vs Temperature

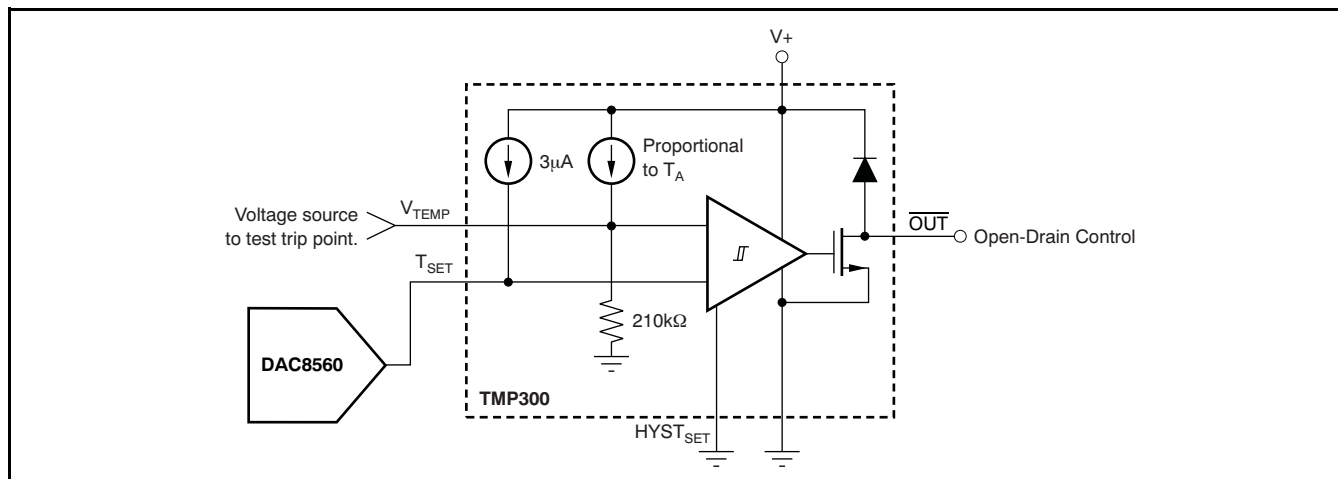


Figure 11. DAC Generates the Voltage-Driving T_{SET} Pin

HYSTERESIS

The hysteresis pin has two settings. Grounding HYST_{SET} results in 5°C of hysteresis. Connecting it to V_S results in 10°C of hysteresis. Hysteresis error variation over temperature is shown in Figure 12 and Figure 13.

Bypass capacitors should be used on the supplies as well as on the R_{SET} and analog out (V_{TEMP}) pins when in noisy environments, as shown in Figure 14. These capacitors reduce premature triggering of the comparator.

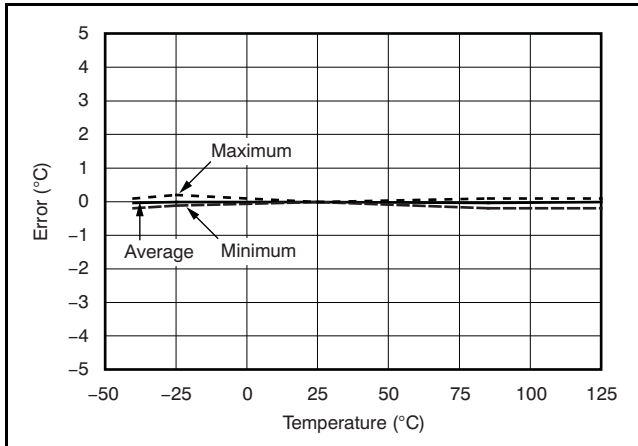


Figure 12. 5°C Hysteresis Error vs Temperature

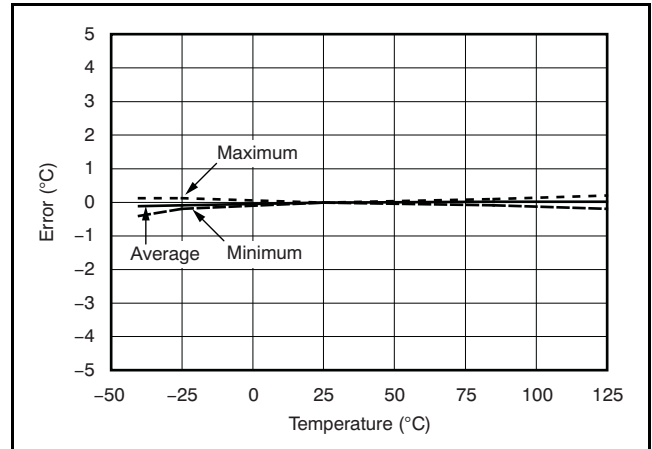


Figure 13. 10°C Hysteresis Error vs Temperature

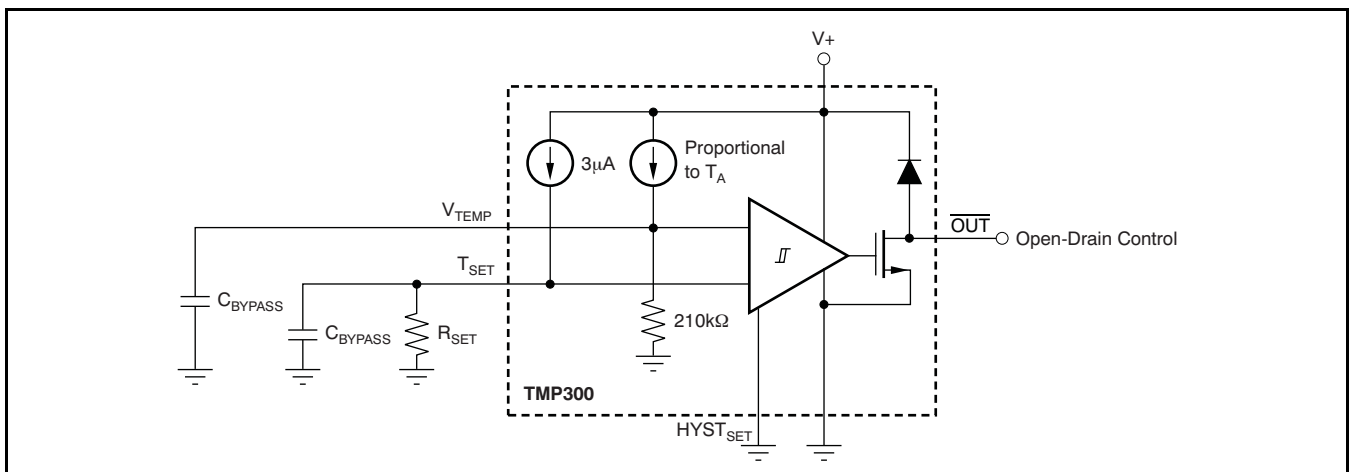


Figure 14. Bypass Capacitors Prevent Early Comparator Toggling Due to Circuit Board Noise

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
TMP300BQDCKRQ1	ACTIVE	SC70	DCK	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SBG	Samples

(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.

OBSELETE: 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.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF TMP300-Q1 :

- Catalog: [TMP300](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TMP300BQDCKRQ1	SC70	DCK	6	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS

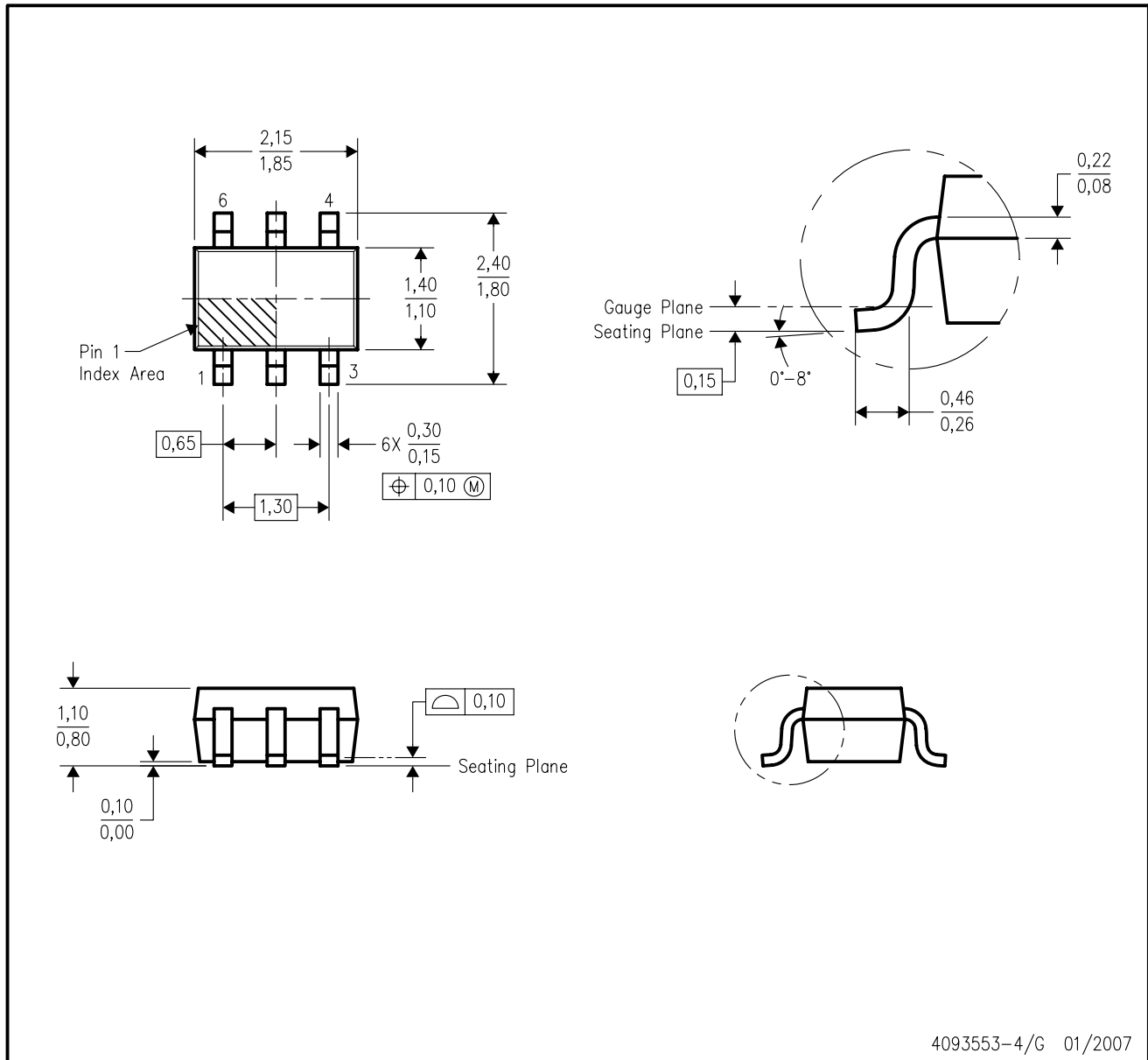


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TMP300BQDCKRQ1	SC70	DCK	6	3000	203.0	203.0	35.0

DCK (R-PDSO-G6)

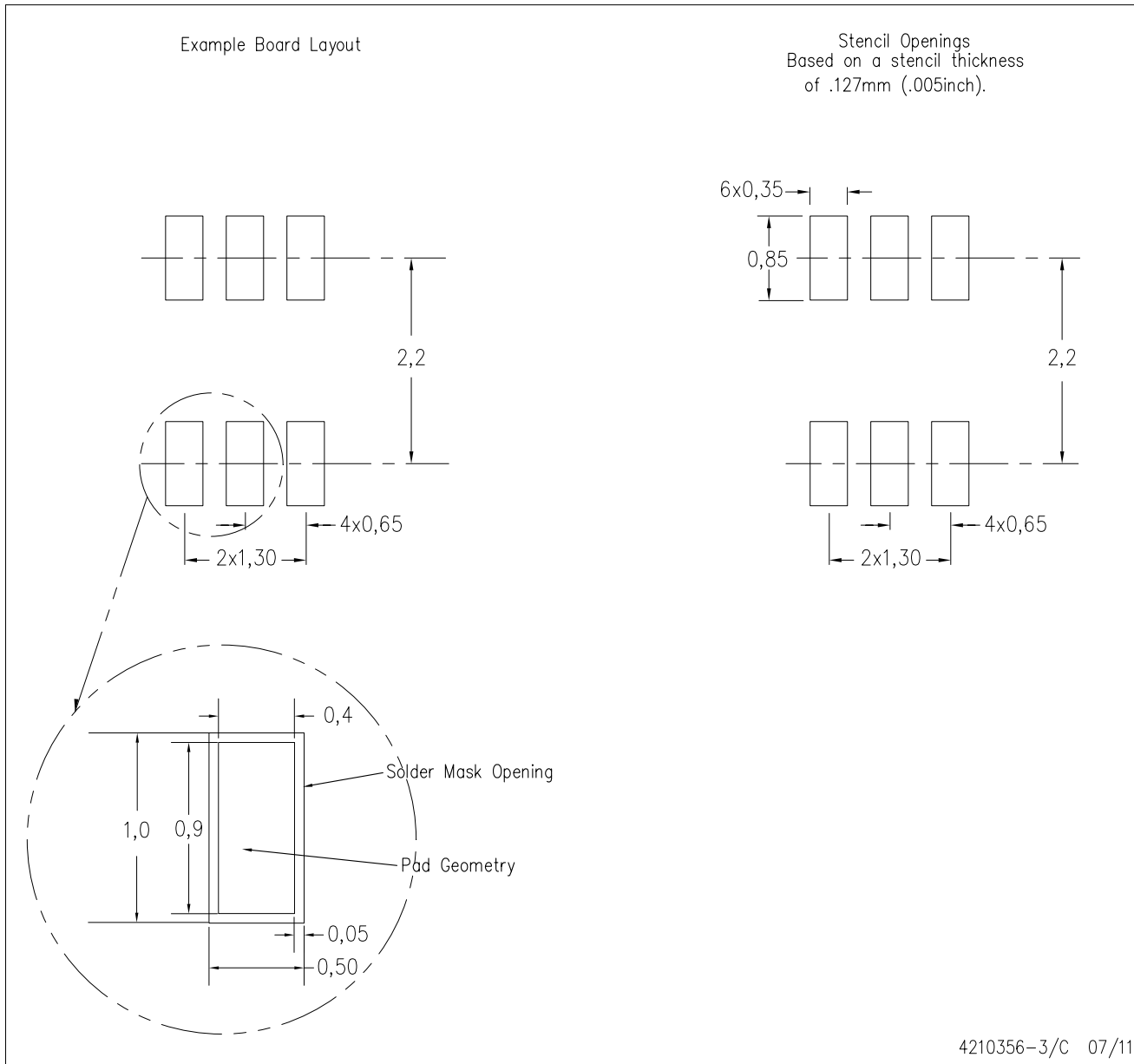
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
 - D. Falls within JEDEC MO-203 variation AB.

DCK (R-PDSO-G6)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
 - Publication IPC-7351 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

IMPORTANT NOTICE

Texas Instruments Incorporated (TI) reserves the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

TI's published terms of sale for semiconductor products (<http://www.ti.com/sc/docs/stdterms.htm>) apply to the sale of packaged integrated circuit products that TI has qualified and released to market. Additional terms may apply to the use or sale of other types of TI products and services.

Reproduction of significant portions of TI information in TI data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such reproduced documentation. Information of third parties may be subject to additional restrictions. Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyers and others who are developing systems that incorporate TI products (collectively, "Designers") understand and agree that Designers remain responsible for using their independent analysis, evaluation and judgment in designing their applications and that Designers have full and exclusive responsibility to assure the safety of Designers' applications and compliance of their applications (and of all TI products used in or for Designers' applications) with all applicable regulations, laws and other applicable requirements. Designer represents that, with respect to their applications, Designer has all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. Designer agrees that prior to using or distributing any applications that include TI products, Designer will thoroughly test such applications and the functionality of such TI products as used in such applications.

TI's provision of technical, application or other design advice, quality characterization, reliability data or other services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using TI Resources in any way, Designer (individually or, if Designer is acting on behalf of a company, Designer's company) agrees to use any particular TI Resource solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

Designer is authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS. TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY DESIGNER AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Unless TI has explicitly designated an individual product as meeting the requirements of a particular industry standard (e.g., ISO/TS 16949 and ISO 26262), TI is not responsible for any failure to meet such industry standard requirements.

Where TI specifically promotes products as facilitating functional safety or as compliant with industry functional safety standards, such products are intended to help enable customers to design and create their own applications that meet applicable functional safety standards and requirements. Using products in an application does not by itself establish any safety features in the application. Designers must ensure compliance with safety-related requirements and standards applicable to their applications. Designer may not use any TI products in life-critical medical equipment unless authorized officers of the parties have executed a special contract specifically governing such use. Life-critical medical equipment is medical equipment where failure of such equipment would cause serious bodily injury or death (e.g., life support, pacemakers, defibrillators, heart pumps, neurostimulators, and implantables). Such equipment includes, without limitation, all medical devices identified by the U.S. Food and Drug Administration as Class III devices and equivalent classifications outside the U.S.

TI may expressly designate certain products as completing a particular qualification (e.g., Q100, Military Grade, or Enhanced Product). Designers agree that it has the necessary expertise to select the product with the appropriate qualification designation for their applications and that proper product selection is at Designers' own risk. Designers are solely responsible for compliance with all legal and regulatory requirements in connection with such selection.

Designer will fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of Designer's non-compliance with the terms and provisions of this Notice.

Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

 [View TMP300BQDCKRQ1 on WIN SOURCE](#)

 [Texas Instruments](#) Information

Optimize Your Supply Chain with WIN SOURCE Solutions

-  Global Sourcing Solution
-  Obsolete Management
-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management