

POWER MANAGEMENT

60mA/110mA/160mA Super Low Dropout CMOS Regulators with Battery Life Extending Shutdown Mode and ERROR Output

The IMP2054, IMP2055 and IMP2186 high performance CMOS low dropout voltage regulators offer superior dropout voltage performance and load regulation characteristics as compared to the pin compatible TC1054/1055/1186 devices offered by TelCom Semiconductor. Dropout voltage performance has been improved by up to 40%.

Load regulation and power supply PSRR have been optimized. Load regulation is typically 0.32% and PSRR is 53dB at 1kHz.

A logic input controlled shutdown mode extends system battery life by reducing quiescent current to 0.2µA maximum. The shutdown mode can be initiated by a system microcontroller.

The regulators were designed with ease of use and stability in mind. Stability is guaranteed for 0.47µF and greater load capacitors with an ESR up to 5Ω. Ceramic or tantalum capacitors can be used.

Three devices with different guaranteed output current specifications are available: IMP2054 (60mA), IMP2055 (110mA) and IMP2186 (160mA). Each device has output voltage options of 2.5V, 2.7V, 2.85V, 3.0V, 3.3V, 3.6V and 4.0V.

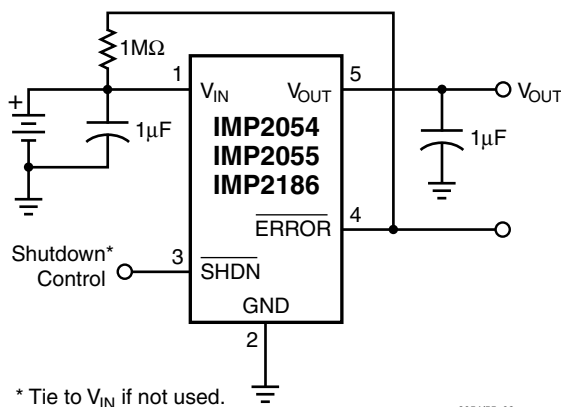
Key Features

- ◆ Pin Compatible with TelCom TC1054/1055/1186
- ◆ Lower Dropout Voltage for Long Battery Life
 - IMP2054: 70mV vs. TelCom TC1054 120mV
 - IMP2055: 160mV vs. TelCom TC1055 250mV
 - IMP2186: 250mV vs. TelCom TC1186 400mV
- ◆ Power Saving Shutdown Mode
 - 0.2µA shutdown current
- ◆ ERROR Output
 - Low battery detection
 - Processor reset
- ◆ Superior Load Regulation
 - 0.32%
- ◆ Long Battery Life
 - 33µA no load ground current
- ◆ Accurate Output Voltage
 - ± 2.5% over temperature
- ◆ Low Drift Output: 40ppm/°C
- ◆ Guaranteed Minimum Output Current
 - IMP2054: 60mA
 - IMP2055: 110mA
 - IMP2186: 160mA
- ◆ Over-Current and Over-Temperature Protection
- ◆ Compact SOT-23A-5 Package

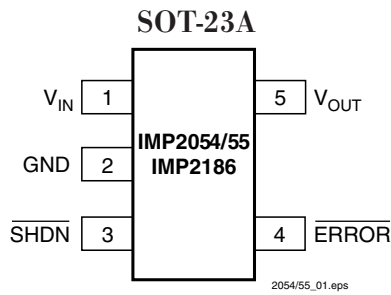
Applications

- ◆ Pagers
- ◆ Cellular/GSM/PHS Phones
- ◆ Instrumentation
- ◆ Wireless Terminals
- ◆ Battery Powered Systems
- ◆ Medical Instruments
- ◆ Linear Post-Regulators

Typical Application



Pin Configuration



Pin Descriptions

Pin Number	Name	Function
1	V _{IN}	Unregulated supply input.
2	GND	Ground terminal.
3	SHDN	Shutdown control input. A shutdown mode is entered when SHDN is a logic LOW. During shutdown the output voltage falls to 0V and quiescent current drops to 2.0μA.
4	ERROR	Out-of-Regulation Flag output. An open drain output that goes LOW when the output is out-of-tolerance by approximately 5%.
5	V _{OUT}	Output voltage

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Ordering Information

Part Number*	Package	Output Voltage (V)	Output Current (mA)	Shutdown Pin	Adjust Pin	ERROR Flag Output	Reference Bypass Pin	Package Marking			
								A	B	C	D
IMP2054-2.5JUK/T	SOT23A-5	2.5	60	●		●		R	A	x	x
IMP2054-2.7JUK/T	SOT23A-5	2.7	60	●		●		R	B	x	x
IMP2054-2.85JUK/T	SOT23A-5	2.85	60	●		●		R	C	x	x
IMP2054-3.0JUK/T	SOT23A-5	3.0	60	●		●		R	D	x	x
IMP2054-3.3JUK/T	SOT23A-5	3.3	60	●		●		R	E	x	x
IMP2054-3.6JUK/T	SOT23A-5	3.6	60	●		●		R	F	x	x
IMP2054-4.0JUK/T	SOT23A-5	4.0	60	●		●		R	G	x	x
IMP2055-2.5JUK/T	SOT23A-5	2.5	110	●		●		T	A	x	x
IMP2055-2.7JUK/T	SOT23A-5	2.7	110	●		●		T	B	x	x
IMP2055-2.85JUK/T	SOT23A-5	2.85	110	●		●		T	C	x	x
IMP2055-3.0JUK/T	SOT23A-5	3.0	110	●		●		T	D	x	x
IMP2055-3.3JUK/T	SOT23A-5	3.3	110	●		●		T	E	x	x
IMP2055-3.6JUK/T	SOT23A-5	3.6	110	●		●		T	F	x	x
IMP2055-4.0JUK/T	SOT23A-5	4.0	110	●		●		T	G	x	x
IMP2186-2.5JUK/T	SOT23A-5	2.5	160	●		●		Y	A	x	x
IMP2186-2.7JUK/T	SOT23A-5	2.7	160	●		●		Y	B	x	x
IMP2186-2.85JUK/T	SOT23A-5	2.85	160	●		●		Y	C	x	x
IMP2186-3.0JUK/T	SOT23A-5	3.0	160	●		●		Y	D	x	x
IMP2186-3.3JUK/T	SOT23A-5	3.3	160	●		●		Y	E	x	x
IMP2186-3.6JUK/T	SOT23A-5	3.6	160	●		●		Y	F	x	x
IMP2186-4.0JUK/T	SOT23A-5	4.0	160	●		●		Y	G	x	x

xx = Date Code

* /T indicates Tape and Reel

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Absolute Maximum Ratings

Input Voltage 7V
 Output Voltage -0.3V to $V_{IN} + 0.3V$
 Maximum Voltage on Any Pin -0.3V to $(V_{IN} + 0.3V)$
 Shutdown Voltage (\overline{SHDN}) $\overline{SHDN} \leq V_{IN} + 0.3V$

Operating Junction Temperature Range ... $-40^{\circ}C < T_J < 125^{\circ}C$
 Storage Temperature $-65^{\circ}C$ to $150^{\circ}C$
 Power Dissipation Internally limited

Note: T_J = Junction Temperature, T_A = Ambient Temperature

These are stress ratings only and functional operation is not implied. Exposure to absolute maximum ratings for prolonged time periods may affect device reliability. All voltages are with respect to ground.

Electrical Characteristics

$V_{IN} = V_{OUT} + 1V$, $I_L = 100\mu A$, $C_L = 1\mu F$, $\overline{SHDN} > V_{IH}$, $T_A = 25^{\circ}C$, unless otherwise noted. **Bold/blue** specifications apply for junction temperature range $-40^{\circ}C < T_J < 125^{\circ}C$.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Input Voltage Range	V_{IN}	$0^{\circ}C < T_J < 125^{\circ}C$			6.50	V
		$-40^{\circ}C < T_J < 125^{\circ}C$			6.50	
Maximum Output Current	I_{OMAX}	IMP2054	60			mA
		IMP2055	110			
		IMP2186	160			
Fixed Output Voltage	V_{OUT}	Note 1	$V_R - 2.5\%$	$V_R \pm 0.5\%$	$V_R + 2.5\%$	V
Dropout Voltage (Note 2)	$V_{IN} - V_O$	$I_L = 100\mu A$		1		mV
		$I_L = 20mA$		17	23	
		$I_L = 50mA$		60	70	
		$I_L = 100mA$ (IMP2054, IMP2186)		90	160	
		$I_L = 150mA$ (IMP2186)		143	250	
Quiescent Current (Ground Current)		No load		33	50	μA
Shutdown Supply Current	I_{INSD}	$\overline{SHDN} = 0V$ $T_J \leq 25^{\circ}C$		0.2	2	μA
Output Temperature Coefficient				40		ppm/ $^{\circ}C$
Thermal Regulation				0.04		%/W
Line Regulation		$V_R + 1V \leq V_{IN} \leq 6V$		0.0375	0.35	%

- Notes: 1. V_R is the regulated output voltage: 2.5V, 2.7V, 2.85V, 3.0V, 3.3V, 3.6V or 4.0V.
 2. Dropout Voltage is defined as the difference between IN and OUT when V_R drops 2% below its nominal value.
 3. Specifications which would otherwise be affected by self-heating of the die are tested at a constant die temperature by using low duty cycle pulse testing.
 3. PSRR guaranteed by design.

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Electrical Characteristics

$V_{IN} = V_{OUT} + 1V$, $I_L = 100\mu A$, $C_L = 1\mu F$, $\overline{SHDN} > V_{IH}$, $T_A = 25^\circ C$, unless otherwise noted. **Bold/blue** specifications apply for junction temperature range of $-40^\circ C < T_J < 125^\circ C$.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Load Regulation: IMP2054		$I_L = 100\mu A$ to 50mA		0.32	2.0	%
IMP2055		$I_L = 100\mu A$ to 100mA		0.32	2.0	
IMP2186		$I_L = 100\mu A$ to 150mA		0.32	3.0	
Thermal Shutdown Die Temperature				150		$^\circ C$
Thermal Shutdown Hysteresis				12		$^\circ C$
Ripple Rejection	PSRR	$V_{IN} \geq (V_O + 1V) \pm 0.25V$ $C_O = 3.3\mu F$ ceramic				dB
				58		
				45		
				34		
Output Noise		300Hz to 50kHz $I_L = 50mA$ (IMP2054) $I_L = 100mA$		280		μV_{RMS}
\overline{SHDN} Input HIGH Threshold		$2.5V \leq V_{IN} \leq 6.5V$	45			% of V_{IN}
\overline{SHDN} Input LOW Threshold		$2.5V \leq V_{IN} \leq 6.5V$			15	% of V_{IN}
\overline{ERROR} Flag Minimum Supply Voltage			1.5			V
\overline{ERROR} Flag Threshold Voltage		V_{TH}		$0.95V_R$		V
\overline{ERROR} Flag Hysteresis		V_{HYS}		50		mV
\overline{ERROR} Flag Output Low Voltage		$I_{ERROR} = 1mA$		75	400	mV
Reverse Current into V_{OUT}		$V_{(IN)} < V_{(OUT)}$ $\overline{SHDN} = HIGH = V_{IN}$		2.0		mA
		$V_{(IN)} < V_{(OUT)}$ $\overline{SHDN} = LOW$		2.7		μA
Output Current Limit				350	600	mA

Notes: 1. V_R is the regulated output voltage: 2.5V, 2.7V, 2.85V, 3.0V, 3.3V, 3.6V or 4.0V.

2. Dropout Voltage is defined as the difference between IN and OUT when V_R drops 2% below its nominal value.

3. Specifications which would otherwise be affected by self-heating of the die are tested at a constant die temperature by using low duty cycle pulse testing.

4. PSRR guaranteed by design.

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Typical Characteristics

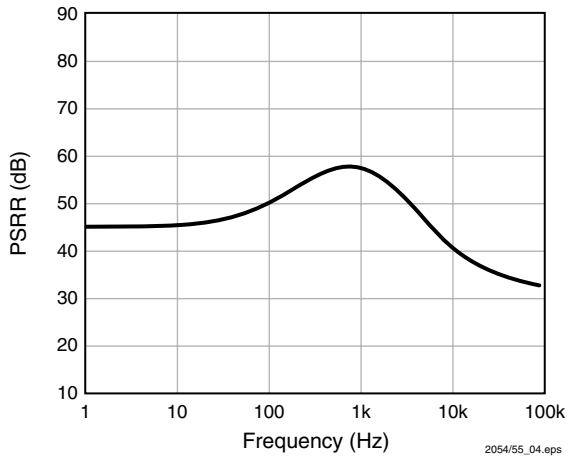


Figure 1. IMP2055 PSRR at $I_{LOAD} = 100mA$

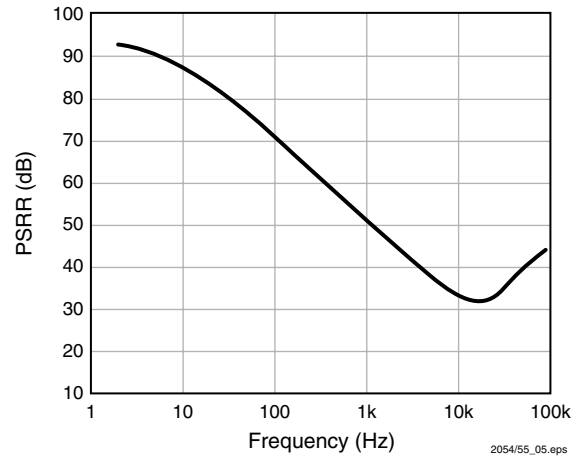


Figure 2. IMP2055 PSRR at $I_{LOAD} = 1mA$

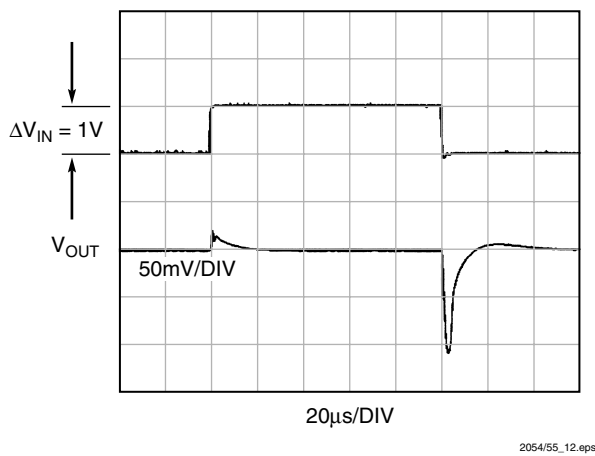


Figure 3. Line Transient Response

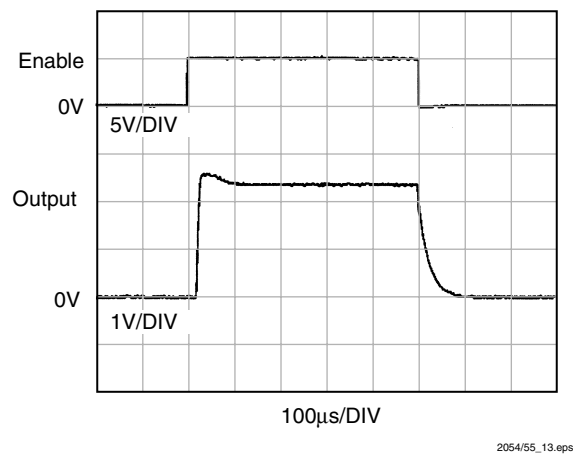


Figure 4. Enable Input Response

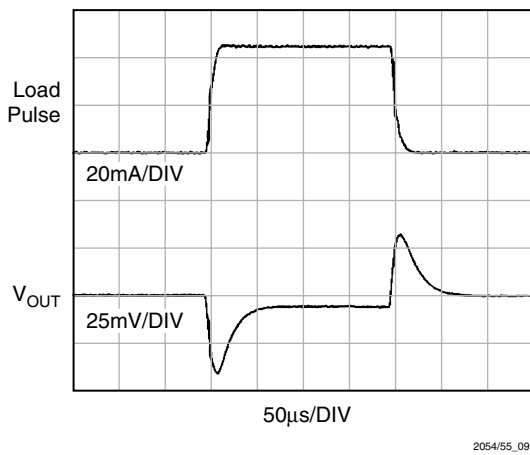


Figure 5. Load Transient Response (50mA Step)

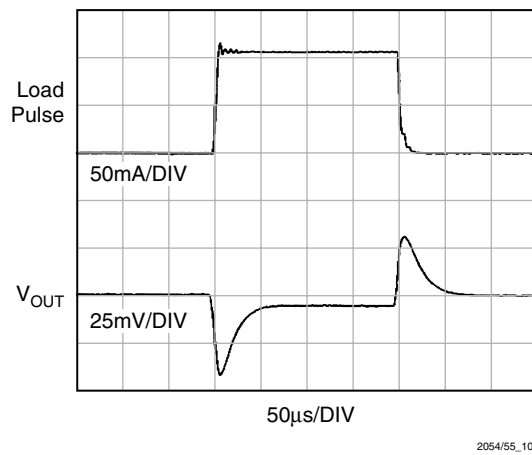
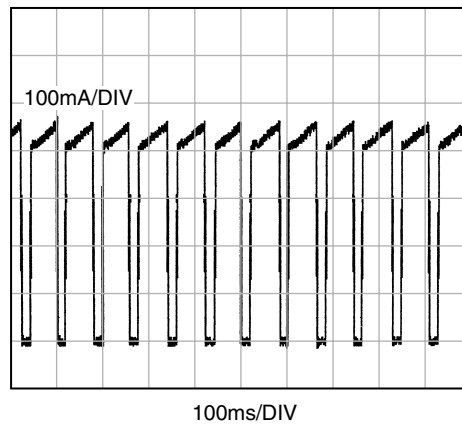


Figure 6. Load Transient Response (100mA Step)

Typical Characteristics



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Figure 7. Output Short Circuit Response

Application Information

The IMP2054, IMP2055 and IMP2186 have been designed to offer exceptionally low dropout voltage, superior load regulation and minimum quiescent power.

Shutdown Mode

A battery-life-extending mode is available. Through the active LOW shutdown pin, $\overline{\text{SHDN}}$, the regulator can be enabled or turned off. The regulator is shutdown (turned off) when $\overline{\text{SHDN}}$ is LOW and enabled (turned on) when $\overline{\text{SHDN}}$ is HIGH.

The shutdown signal can be supplied from a CMOS gate or from an I/O port of a microcontroller.

During shutdown, the output voltage falls to 0V and the supply current is typically only 200nA.

If the shutdown mode is not needed, $\overline{\text{SHDN}}$ should be connected directly to the regulator input voltage pin.

$\overline{\text{ERROR}}$ Open Drain Output

$\overline{\text{ERROR}}$ is driven low whenever V_{OUT} falls out of regulation by more than 5 percent typically. This condition may be caused by low input voltage, output current limiting, or thermal limiting. The $\overline{\text{ERROR}}$ threshold is 5% below rated V_{OUT} regardless of the programmed output voltage value (e.g. $\overline{\text{ERROR}} = V_{\text{OL}}$ at 4.7V (typical) for a 5.0V regulator and 2.85V (typical) for a 3.0V regulator). $\overline{\text{ERROR}}$ output operation is shown in Figure 8.

Note that $\overline{\text{ERROR}}$ is active when V_{OUT} falls to V_{TH} and inactive when V_{OUT} rises above V_{TH} by V_{HYS} .

As shown in Figure 9, $\overline{\text{ERROR}}$ can be used as a battery low flag, or as a microcontroller $\overline{\text{RESET}}$ signal (with the addition of timing capacitor C2). $R1 \times C2$ should be chosen to maintain $\overline{\text{ERROR}}$ below V_{IH} of the processor $\overline{\text{RESET}}$ input for at least 200ms to allow time for the system to stabilize.

Output Capacitor

The IMP2054, IMP2055 and IMP2186 were designed for stable operation with a wide range of capacitor values and type. The output capacitor should be above 0.47 μF . A 1 μF value is recommended. Ceramic or tantalum capacitors are suitable with an ESR up to 5 Ω .

Thermal Shutdown

An on-chip thermal protection circuit shuts the LDO regulator off when the die temperature exceeds 150 $^{\circ}\text{C}$. There is a built in 12 $^{\circ}\text{C}$ hysteresis. The regulator will remain off until the die temperature drops to approximately to 138 $^{\circ}\text{C}$.

Application Information

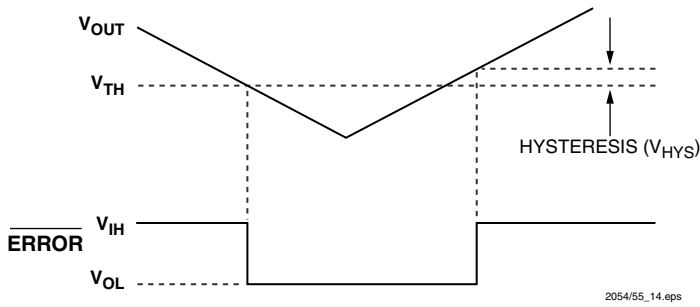


Figure 8. $\overline{\text{ERROR}}$ Output Operation

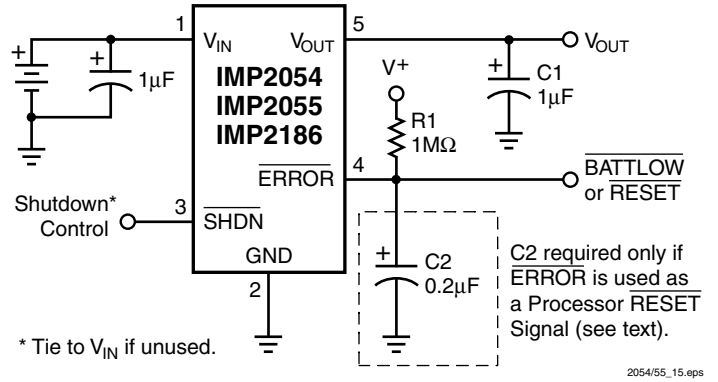
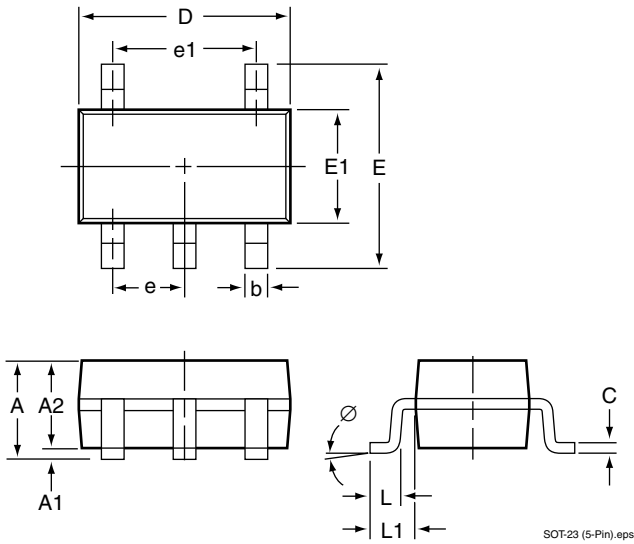


Figure 9. Typical Application Circuit

Package Dimensions

Plastic SOT-23A (5-Pin)



	Inches			Millimeters		
	Min	Nominal	Max	Min	Nominal	Max
Plastic SOT-23 (5-Pin)*						
A	0.037	—	0.057	0.95	—	1.45
A1	0.001	—	0.005	0.05	—	0.15
A2	0.035	0.044	0.050	0.90	1.15	1.30
b	0.011	—	0.019	0.30	—	0.50
b1	0.011	0.015	0.017	0.30	0.40	0.45
c	0.003	—	0.007	0.08	—	0.20
c1	0.003	0.003	0.062	0.08	0.10	0.16
D	0.109	0.113	0.117	2.80	2.90	3.00
E	0.101	—	0.117	2.60	—	3.00
E1	0.058	0.062	0.066	1.50	1.60	1.70
e	0.037 BSC			0.95 BSC		
e1	0.074 BSC			1.90 BSC		
L	0.013	0.017	0.021	0.35	0.45	0.55
L1	0.002 REF			0.60 REF		
∅	0°	—	8°	0°	—	8°

* JEDEC Drawing MO-178

♦ Add /T to Part Number for Tape and Reel.

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