CMOS Digital Integrated Circuits Silicon Monolithic

74LCX138FT

1. Functional Description

- Low-Voltage 3-to-8 Line Decoder with 5-V Tolerant Inputs and Outputs

2. General

The 74LCX138FT is a high-performance CMOS 3 to 8 decoder. Designed for use in 3.3 V systems, it achieves high-speed operation while maintaining the CMOS low-power dissipation.

The device is designed for low-voltage (3.3 V) V_{CC} applications, but it could be used to interface to 5 V supply environment for inputs.

When the device is enabled, 3 binary select inputs (A, B and C) determine which one of the outputs ($\overline{Y0}$-$\overline{Y7}$) will go low.

When enable input G1 is held low or either $\overline{G2A}$ or $\overline{G2B}$ is held high, decoding function is inhibited and all outputs go high.

G1,$\overline{G2A}$, and $\overline{G2B}$ inputs are provided to ease cascade connection and for use as an address decoder for memory systems.

All inputs are equipped with protection circuits against static discharge.

3. Features

(1) AEC-Q100 (Rev. H) (Note 1)

(2) Wide operating temperature range: T_{opr} = -40 to 125 ℃

(3) Low-voltage operation: V_{CC} = 1.65 to 3.6 V

(4) High-speed operation: t_{pd} = 7.0 ns (max) (V_{CC} = 3.3 ± 0.3 V)

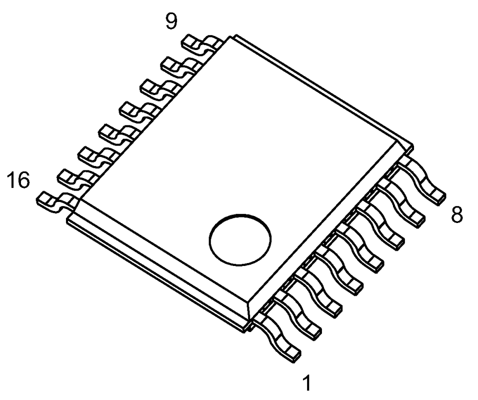
(5) Output current: $|I_{OH}|/I_{OL}$ = 24 mA (min) (V_{CC} = 3.0 V)

(6) Power-down protection provided on all inputs and outputs

(7) Pin and function compatible with the 74 series (74LVC/ALVC/ etc.) 138 type

Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

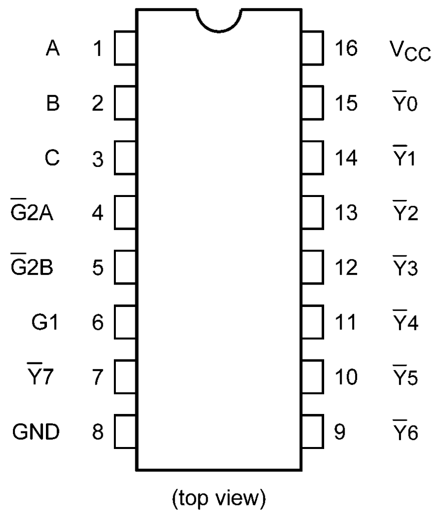
4. Packaging



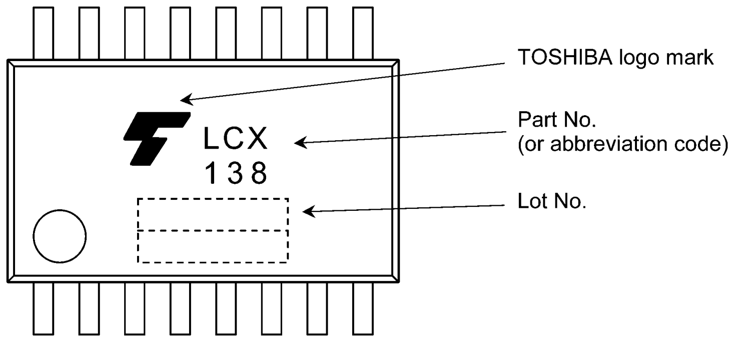
TSSOP16B

Start of commercial production
2014-04

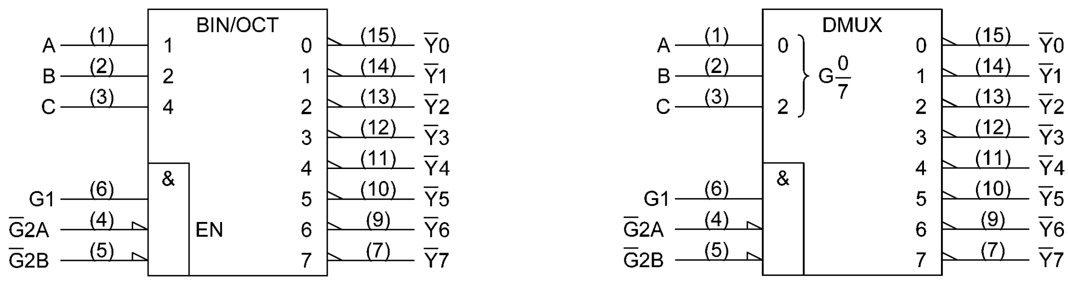
5. Pin Assignment



6. Marking



7. IEC Logic Symbol

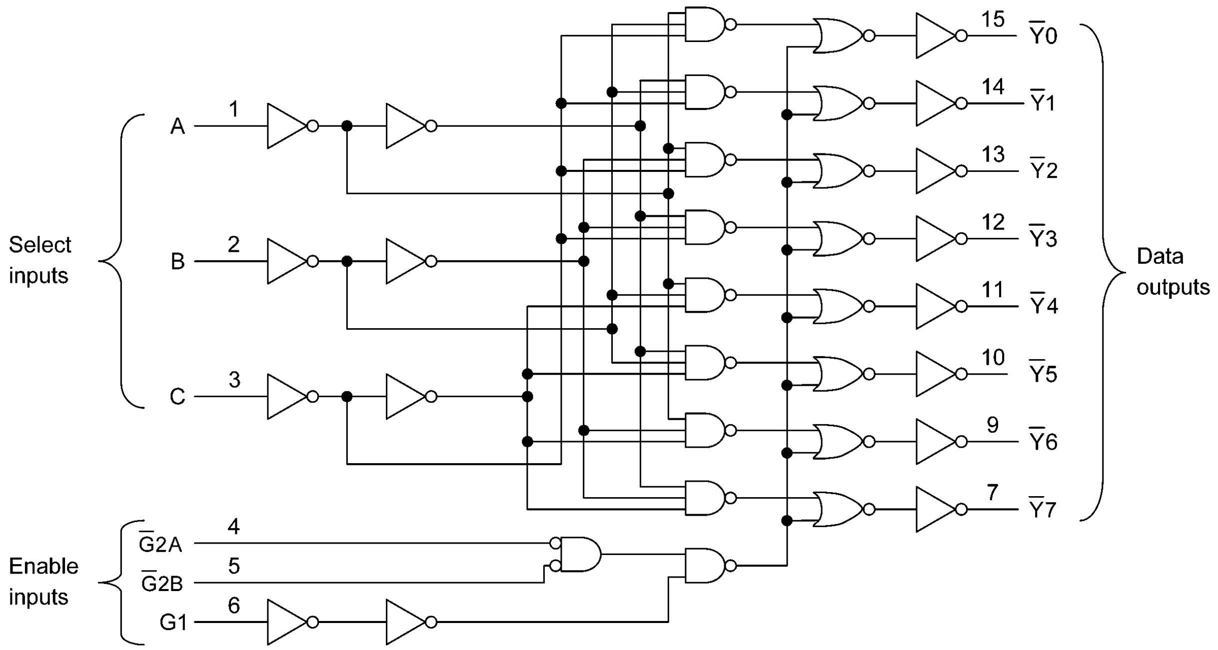


8. Truth Table

Inputs						Outputs								Selected Output
Enable			Select			$\overline{Y0}$	$\overline{Y1}$	$\overline{Y2}$	$\overline{Y3}$	$\overline{Y4}$	$\overline{Y5}$	$\overline{Y6}$	$\overline{Y7}$	
G1	$\overline{G2A}$	$\overline{G2B}$	C	B	A									
L	X	X	X	X	X	H	H	H	H	H	H	H	H	None
X	H	X	X	X	X	H	H	H	H	H	H	H	H	None
X	X	H	X	X	X	H	H	H	H	H	H	H	H	None
H	L	L	L	L	L	L	H	H	H	H	H	H	H	$\overline{Y0}$
H	L	L	L	L	H	H	L	H	H	H	H	H	H	$\overline{Y1}$
H	L	L	L	H	L	H	H	L	H	H	H	H	H	$\overline{Y2}$
H	L	L	L	H	H	H	H	H	L	H	H	H	H	$\overline{Y3}$
H	L	L	H	L	L	H	H	H	H	L	H	H	H	$\overline{Y4}$
H	L	L	H	L	H	H	H	H	H	H	L	H	H	$\overline{Y5}$
H	L	L	H	H	L	H	H	H	H	H	H	L	H	$\overline{Y6}$
H	L	L	H	H	H	H	H	H	H	H	H	H	L	$\overline{Y7}$

X: Don't care

9. System Diagram



10. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		-0.5 to 6.5	V
Input voltage	V_{IN}		-0.5 to 6.5	V
Output voltage	V_{OUT}	(Note 1)	-0.5 to 6.5	V
		(Note 2)	-0.5 to V_{CC} + 0.5	
Input diode current	I_{IK}		-50	mA
Output diode current	I_{OK}	(Note 3)	±50	mA
Output current	I_{OUT}		±50	mA
Power dissipation	P_D	(Note 4)	180	mW
V_{CC}/ground current	I_{CC}/I_{GND}		±100	mA
Storage temperature	T_{stg}		-65 to 150	°C

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.
Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 1: V_{CC} = 0 V

Note 2: High or Low state. I_{OUT} absolute maximum rating must be observed.

Note 3: V_{OUT} < GND, V_{OUT} > V_{CC}

Note 4: 180 mW in the range of T_a = -40 to 85 °C. From T_a = 85 to 125 °C a derating factor of -3.25 mW/°C shall be applied until 50 mW.

11. Operating Ranges (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		1.65 to 3.6	V
		(Note 1)	1.5 to 3.6	
Input voltage	V_{IN}		0 to 5.5	V
Output voltage	V_{OUT}	(Note 2)	0 to 5.5	V
		(Note 3)	0 to V_{CC}	
Output current	I_{OH},I_{OL}	(Note 4)	±24	mA
		(Note 5)	±12	
Operating temperature	T_{opr}		-40 to 125	°C
Input rise and fall times	dt/dv	(Note 6)	0 to 10	ns/V

Note: The operating ranges must be maintained to ensure the normal operation of the device.
Unused inputs must be tied to either V_{CC} or GND.

Note 1: Data retention only.

Note 2: V_{CC} = 0 V

Note 3: High or low state

Note 4: V_{CC} = 3.0 to 3.6 V

Note 5: V_{CC} = 2.7 to 3.0 V

Note 6: V_{IN} = 0.8 to 2.0 V , V_{CC} = 3.0 V

12. Electrical Characteristics

12.1. DC Characteristics (Unless otherwise specified, T_a = -40 to 85 °C)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
High-level input voltage	V_{IH}	—		1.65 to 2.3	V_{CC} × 0.9	—	V
				2.3 to 2.7	1.7	—	
				2.7 to 3.6	2.0	—	
Low-level input voltage	V_{IL}	—		1.65 to 2.3	—	V_{CC} × 0.1	V
				2.3 to 2.7	—	0.7	
				2.7 to 3.6	—	0.8	
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -100 μA	1.65 to 3.6	V_{CC} - 0.2	—	V
			I_{OH} = -4 mA	1.65	1.05	—	
			I_{OH} = -8 mA	2.3	1.7	—	
			I_{OH} = -12 mA	2.7	2.2	—	
			I_{OH} = -18 mA	3.0	2.4	—	
			I_{OH} = -24 mA	3.0	2.2	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	1.65 to 3.6	—	0.2	V
			I_{OL} = 4 mA	1.65	—	0.45	
			I_{OL} = 8 mA	2.3	—	0.7	
			I_{OL} = 12 mA	2.7	—	0.4	
			I_{OL} = 16 mA	3.0	—	0.4	
			I_{OL} = 24 mA	3.0	—	0.55	
Input leakage current	I_{IN}	V_{IN} = 0 to 5.5 V		1.65 to 3.6	—	±5.0	μA
Power-OFF leakage current	I_{OFF}	V_{IN}/V_{OUT} = 5.5 V		0	—	10.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		1.65 to 3.6	—	10.0	μA
		V_{IN}/V_{OUT} = 3.6 to 5.5 V		1.65 to 3.6	—	±10.0	
Quiescent supply current	ΔI_{CC}	V_{IH} = V_{CC} - 0.6 V (per 1 input)		2.7 to 3.6	—	500	μA

12.2. DC Characteristics (Unless otherwise specified, T_a = -40 to 125 °C)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
High-level input voltage	V_{IH}	—		1.65 to 2.3	V_{CC} × 0.9	—	V
				2.3 to 2.7	1.7	—	
				2.7 to 3.6	2.0	—	
Low-level input voltage	V_{IL}	—		1.65 to 2.3	—	V_{CC} × 0.1	V
				2.3 to 2.7	—	0.7	
				2.7 to 3.6	—	0.8	
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -100 μA	1.65 to 3.6	V_{CC} - 0.2	—	V
			I_{OH} = -4 mA	1.65	0.9	—	
			I_{OH} = -8 mA	2.3	1.55	—	
			I_{OH} = -12 mA	2.7	2.0	—	
			I_{OH} = -18 mA	3.0	2.2	—	
			I_{OH} = -24 mA	3.0	2.0	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	1.65 to 3.6	—	0.2	V
			I_{OL} = 4 mA	1.65	—	0.65	
			I_{OL} = 8 mA	2.3	—	0.9	
			I_{OL} = 12 mA	2.7	—	0.6	
			I_{OL} = 16 mA	3.0	—	0.6	
			I_{OL} = 24 mA	3.0	—	0.75	
Input leakage current	I_{IN}	V_{IN} = 0 to 5.5 V		1.65 to 3.6	—	±20.0	μA
Power-OFF leakage current	I_{OFF}	V_{IN}/V_{OUT} = 5.5 V		0	—	40.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		1.65 to 3.6	—	40.0	μA
		V_{IN}/V_{OUT} = 3.6 to 5.5 V		1.65 to 3.6	—	±40.0	
Quiescent supply current	ΔI_{CC}	V_{IH} = V_{CC} - 0.6 V (per 1 input)		2.7 to 3.6	—	5.0	mA

12.3. AC Characteristics (Unless otherwise specified, T_a = -40 to 85 °C)

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Min	Max	Unit
Propagation delay time (A,B,C - $\overline{Y}$)	t_{PLH},t_{PHL}		See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1	1.8 ± 0.15	—	25.0	ns
				2.5 ± 0.2	—	8.0	
				2.7	—	7.0	
				3.3 ± 0.3	1.5	6.0	
Propagation delay time (G1 - $\overline{Y}$)	t_{PLH},t_{PHL}		See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1	1.8 ± 0.15	—	25.0	ns
				2.5 ± 0.2	—	9.0	
				2.7	—	8.0	
				3.3 ± 0.3	1.5	7.0	
Propagation delay time ($\overline{G2}$ - $\overline{Y}$)	t_{PLH},t_{PHL}		See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1	1.8 ± 0.15	—	25.0	ns
				2.5 ± 0.2	—	8.0	
				2.7	—	7.0	
				3.3 ± 0.3	1.5	6.0	
Output skew	t_{osLH},t_{osHL}	(Note 1)	—	2.7	—	—	ns
				3.3 ± 0.3	—	1.0	

Note 1: Parameter guaranteed by design. (t_{osLH} = $|t_{PLH}m - t_{PLH}n|$, t_{osHL} = $|t_{PHL}m - t_{PHL}n|$)

12.4. AC Characteristics (Unless otherwise specified, T_a = -40 to 125 °C)

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Min	Max	Unit
Propagation delay time (A,B,C - $\overline{Y}$)	t_{PLH},t_{PHL}		See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1	1.8 ± 0.15	—	27.5	ns
				2.5 ± 0.2	—	9.0	
				2.7	—	8.0	
				3.3 ± 0.3	1.5	7.0	
Propagation delay time (G1 - $\overline{Y}$)	t_{PLH},t_{PHL}		See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1	1.8 ± 0.15	—	27.5	ns
				2.5 ± 0.2	—	10.0	
				2.7	—	9.0	
				3.3 ± 0.3	1.5	8.0	
Propagation delay time ($\overline{G2}$ - $\overline{Y}$)	t_{PLH},t_{PHL}		See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1	1.8 ± 0.15	—	27.5	ns
				2.5 ± 0.2	—	9.0	
				2.7	—	8.0	
				3.3 ± 0.3	1.5	7.0	
Output skew	t_{osLH},t_{osHL}	(Note 1)	—	2.7	—	—	ns
				3.3 ± 0.3	—	1.0	

Note 1: Parameter guaranteed by design. (t_{osLH} = $|t_{PLHm}-t_{PLHn}|$, t_{osHL} = $|t_{PHLm}-t_{PHLn}|$)

12.5. Dynamic Switching Characteristics (Unless otherwise specified, T_a = 25 °C, Input: t_r = t_f = 2.5 ns, C_L = 50 pF, R_L = 500 Ω)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Quiet output maximum dynamic V_{OL}	V_{OLP}	V_{IH} = 3.3 V, V_{IL} = 0 V	3.3	0.8	V
Quiet output minimum dynamic V_{OL}	$\|V_{OLV}\|$	V_{IH} = 3.3 V, V_{IL} = 0 V	3.3	0.8	V

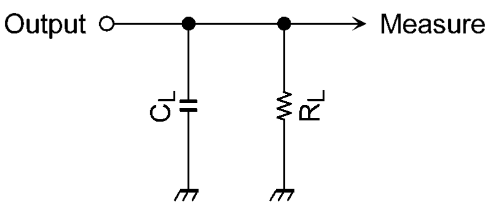
12.6. Capacitive Characteristics (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Typ.	Unit
Input capacitance	C_{IN}			3.3	7	pF
Output capacitance	C_{OUT}			0	8	pF
Power dissipation capacitance	C_{PD}	(Note 1)	f_{IN} = 10 MHz	3.3	25	pF

Note 1: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation.

$I_{CC}(opr) = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$

12.7. AC Test Circuit



12.8. AC Waveform

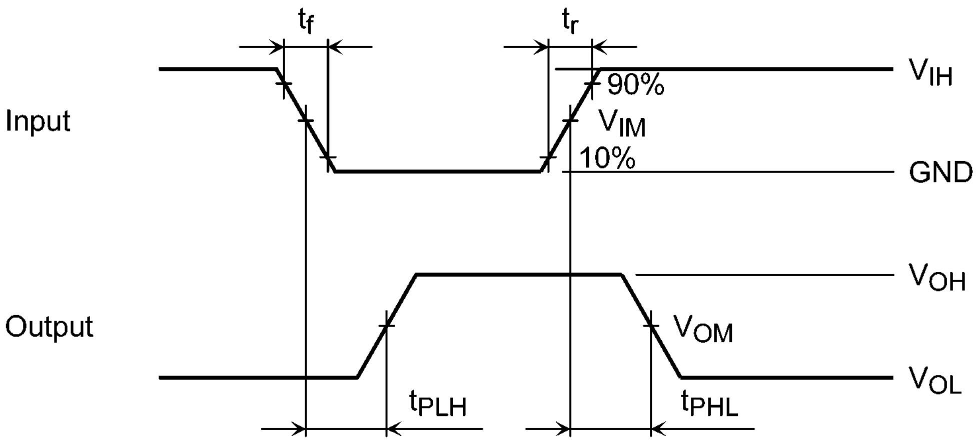


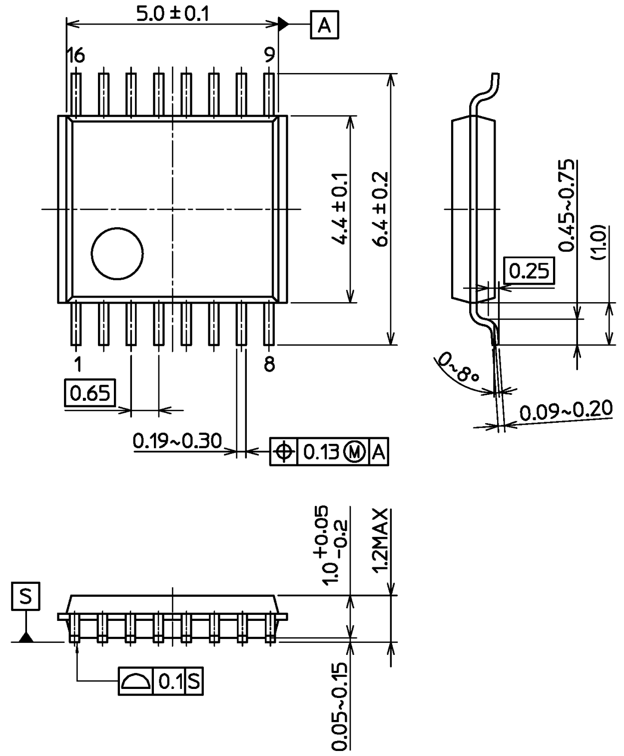
Fig. 12.8.1 t_{PLH}, t_{PHL}

Table 12.8.1 AC Waveform Symbols

	Symbol	V_{CC} = 3.3 ± 0.3 V V_{CC} = 2.7 V	V_{CC} = 2.5 ± 0.2 V	V_{CC} = 1.8 ± 0.15 V
Input	V_{IH}	2.7 V	V_{CC}	V_{CC}
	V_{IM}	1.5 V	$V_{CC}/2$	$V_{CC}/2$
	t_r, t_f	2.5 ns	2.0 ns	2.0 ns
Output	V_{OM}	1.5 V	$V_{OH}/2$	$V_{OH}/2$
Load	C_L	50 pF	30 pF	30 pF
	R_L	500 Ω	500 Ω	1 kΩ

Package Dimensions

Unit: mm



Weight: 0.055 g (typ.)

Package Name(s)
Nickname: TSSOP16B

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