

## Product Specification

### RoHS-6 Compliant 10Gb/s 850nm Multimode X2 Transponder

#### FTLX8541E2/FTLX8541F2

#### PRODUCT FEATURES

- Hot pluggable X2 MSA form factor
- Total power consumption: 2.2 W maximum
- RoHS-6 compliant (lead-free)
- Temperature range 0°C to 70°C
- Transmission distance of 300m
- Uncooled 850 nm VCSEL laser
- SC connector, multimode fiber
- Full duplex transmission mode
- Digital Optics Monitoring (DOM)
- Power supply: +5.0 V, +3.3 V
- Adaptable Power Supply (APS: +1.2 V)
- XAUI electrical interface  
4x 3.125 Gb/s Ethernet (FTLX8541E2)  
4x 3.1875 Gb/s Fibre Channel (FTLX8541F2)
- Management and control via MDIO 2-wire bus
- 70-pin connector
- Separated signal/chassis ground
- Mid Pak module variance for front panel mounting
- De-latch mechanism with low extraction force



#### APPLICATIONS

- 10GBASE-SR 10G Ethernet (FTLX8541E2)
- 1200-Mx-SN-I 10G Fibre Channel: (FTLX8541F2)

#### PRODUCT SELECTION

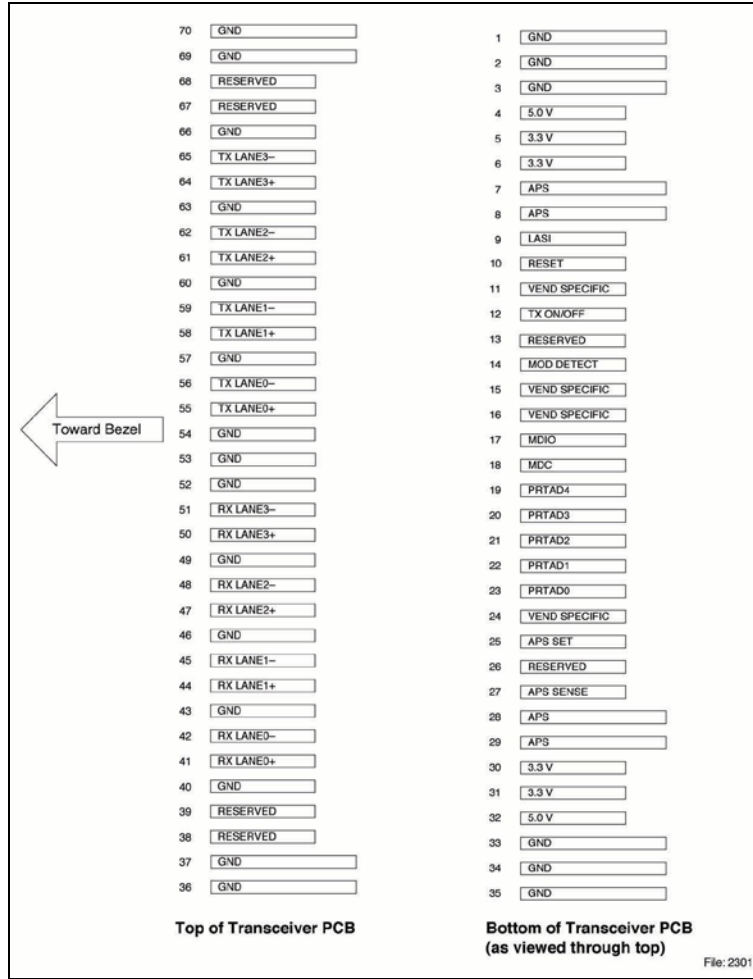
Part Number	Applications
FTLX8541E2	10G Ethernet
FTLX8541F2	10G Fibre Channel

## I. Pin Descriptions

Signal Name	Level	I/O	Pin No.	Description
<b>Management and Monitoring Ports</b>				
MDIO	Open Drain	I/O	17	Management Data I/O. Requires external 10 - 22 kΩ pull-up to the APS on host.
MDC	1.2 V CMOS	I	18	Management Data Clock Input
PRTAD4	1.2 V CMOS	I	19	Port Address Input bit 4
PRTAD3	1.2 V CMOS	I	20	Port Address Input bit 3
PRTAD2	1.2 V CMOS	I	21	Port Address Input bit 2
PRTAD1	1.2 V CMOS	I	22	Port Address Input bit 1
PRTAD0	1.2 V CMOS	I	23	Port Address Input bit 0
LASI	Open Drain	O	9	Link Alarm Status Interrupt Output. Open Drain Compatible Output with 10 - 20 kΩ pull-up on host. Logic high = Normal Operation Logic low = Status Flag Triggered
RESET	Open Drain	I	10	Reset Input. Open Drain Compatible Input with 22 kΩ pull-up to APS internal to transponder. Logic high = Normal Operation Logic low = RESET
Vendor Specific			11,15,16,24	Vendor Specific Pins. Leave unconnected when not used.
TX ON/OFF	Open Drain	I	12	TX ON/OFF Input. Open Drain Compatible Input with 22 kΩ pull-up to APS internal to transponder. Logic high = Transmitter On Logic low = Transmitter Off
MOD DETECT		O	14	Pulled low inside transponder through a 1 kΩ resistor to Ground
<b>Transmit Functions</b>				
Reserved		I	68	Reserved For Future Use
Reserved		I	67	Reserved For Future Use
TX LANE 3– TX LANE 3+	AC-coupled, Internally biased differential XAUI	I	65	Module XAUI Input Lane 3–
		I	64	Module XAUI Input Lane 3+
TX LANE 2– TX LANE 2+		I	62	Module XAUI Input Lane 2–
		I	61	Module XAUI Input Lane 2+
TX LANE 1– TX LANE 1+		I	59	Module XAUI Input Lane 1–
		I	58	Module XAUI Input Lane 1+
TX LANE 0– TX LANE 0+		I	56	Module XAUI Input Lane 0–
	I	55	Module XAUI Input Lane 0+	

<b>Receive Functions</b>				
Reserved		O	38	Reserved For Future Use
Reserved		O	39	Reserved For Future Use
RX LANE 0+	AC-coupled, Internally biased differential XAUI	O	41	Module XAUI Output Lane 0+
RX LANE 0-		O	42	Module XAUI Output Lane 0-
RX LANE 1+		O	44	Module XAUI Output Lane 1+
RX LANE 1-		O	45	Module XAUI Output Lane 1-
RX LANE 2+		O	47	Module XAUI Output Lane 2+
RX LANE 2-		O	48	Module XAUI Output Lane 2-
RX LANE 3+		O	50	Module XAUI Output Lane 3+
RX LANE 3-		O	51	Module XAUI Output Lane 3-
<b>DC Power</b>				
GND	0 V DC		1, 2, 3, 33, 34, 35, 36, 37, 40, 43, 46, 49, 52, 53, 54, 57, 60, 63, 66, 69, 70	Ground connection for signal ground on the module
APS	+1.2 V		7, 8, 28, 29	Input from Adaptive Power Supply
APS SENSE	+1.2 V		27	APS Sense Output. Connected to the APS input inside transponder.
APS SET			25	Feedback input from APS. Connected to GND through a 1180Ω resistor inside the transponder.
3.3 V	+3.3 V DC		5, 6, 30, 31	DC Power Input, +3.3 V DC, Nominal
5.0 V	+5.0 V DC		4, 32	DC Power Input, +5.0 V DC, Nominal
Reserved			26	Reserved for APD.
Reserved			13	Reserved.

### Electrical Pad Layout



**Fig 1-X2 Transponder Electrical Pad Layout**

### II. Absolute Maximum Ratings

Parameter	Symbol	Limit Values		Unit
		min.	max.	
Storage Ambient Temperature <sup>1)</sup>	$T_S$	-40	85	°C
Operating Case Temperature <sup>1)</sup>	$T_C$	0	70	°C
Supply Voltage +5.0 V	$V_5$	0	6	V
Supply Voltage +3.3 V	$V_3$	0	4	V
Supply Voltage APS	$V_{aps}$	0	1.5	V
Static Discharge Voltage, All Pins <sup>2)</sup>	$ST_d$		500	V
Average Receive Optical Power	$RxP_{max}$		1.5	dBm

Notes:

- 1) Non-condensing.
- 2) HBM.

Exceeding any one of these values may permanently destroy the device.

### III. Electrical Characteristics

#### Recommended Operating Conditions

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Operating Case Temperature <sup>1)</sup>	$T_C$	0		70	°C
Transponder Total Power Consumption	$P$			2.2	W
Supply Voltage +5.0 V	$V_{CC5}$	4.75	5.0	5.25	V
Supply Current +5.0 V	$I_{CC5}$		157	190	mA
Supply Voltage +3.3 V	$V_{CC3}$	3.14	3.3	3.47	V
Supply Current +3.3 V	$I_{CC3}$		55	72	mA
Supply Voltage APS	$V_{CC\text{aps}}$	1.152	1.2	1.248	V
Supply Current APS	$I_{CC\text{aps}}$		830	850	mA

<sup>1)</sup> Measured at reference thermal location, see **Figure 2**.  
See also **Environmental Performance**.

#### Electrical DC Characteristics

( $V_{CC5}$  = 4.75 V to 5.25 V,  $V_{CC3}$  = 3.14 V to 3.47 V,  $V_{CC\text{aps}}$  = 1.152 V to 1.248 V,  $T_C$  = 0°C to 70°C)

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
<b>1.2 V CMOS (1.8 V CMOS Compatible<sup>1)</sup>) I/O DC Characteristics (PRTAD; LASI; RESET; TX_ONOFF)</b>					
External Pull-up Resistor for Open Drain	$R_{\text{pullup}}$	10		22	k $\Omega$
Output High Voltage <sup>2)</sup>	$V_{\text{oh}}$	1			V
Output Low Voltage <sup>2)</sup>	$V_{\text{ol}}$			0.15	V
Input High Voltage	$V_{\text{ih}}$	0.84		1.5	V
Input Low Voltage	$V_{\text{il}}$			0.36	V
Input Pull-down Current <sup>3)</sup>	$I_{\text{pd}}$	20		120	$\mu$ A
<b>XAUI I/O DC Characteristics (TXLANE[0..3]; RXLANE[0..3])</b>					
Differential Input Amplitude (pk-pk) <sup>4)</sup>	$V_{\text{in\_xaui}}$	200		2500	mV
Differential Output Amplitude (pk-pk) <sup>4)</sup>	$V_{\text{out\_xaui}}$	800		1600	mV
<b>MDIO I/O DC Characteristics (MDIO; MDC)</b>					
Output Low Voltage <sup>5)</sup>	$V_{\text{OL}}$	-0.3		0.2	V
Output Low Current	$I_{\text{OL}}$			20	mA
Input High Voltage	$V_{\text{IH}}$	0.84		1.5	V
Input Low Voltage	$V_{\text{IL}}$	-0.3		0.36	V
Pull-up Supply Voltage	$V_{\text{PU}}$	0.84	1.2	1.5	V
Input Capacitance	$C_{\text{IN}}$			10	pF
Load Capacitance	$C_{\text{LOAD}}$			470	pF
External Pull-up Resistance	$R_{\text{LOAD}}$	200			$\Omega$

<sup>1)</sup> For 1.8 V CMOS  $V_{\text{oh}}$  = 1.65 V min.,  $V_{\text{ol}}$  = 0.15 V max.,  $V_{\text{ih}}$  = 1.17 V min.,  $V_{\text{il}}$  = 0.63 V max.

<sup>2)</sup>  $R_{\text{pull-up}}$  = 10 k $\Omega$  to 1.8 V.

<sup>3)</sup>  $V_{\text{in}}$  = 1.8 V.

<sup>4)</sup> AC coupled.

<sup>5)</sup>  $I_{\text{OL}}$  = 100  $\mu$ A

**Electrical AC Characteristics**(V<sub>CC5</sub> = 4.75 V to 5.25 V, V<sub>CC3</sub> = 3.14 V to 3.47 V, V<sub>CCaps</sub> = 1.152 V to 1.248 V, T<sub>C</sub> = 0°C to 70°C)

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
<b>XAUI Input AC Characteristics (TXLANE[0..3])</b>					
Baud Rate Fibre Channel Ethernet	R <sub>XAUIIN</sub>		3.1875 3.125		Gbit/s
Baud Rate Tolerance	R <sub>TOLXAUI</sub>	-100		100	ppm
Differential Input Impedance	Z <sub>INXAUI</sub>	80	100	120	Ω
Differential Return Loss <sup>1)</sup>	S <sub>11</sub>	10			dB
Input Differential Skew <sup>2)</sup>	t <sub>SKEWIN</sub>			75	ps
Jitter Amplitude Tolerance <sup>3)</sup>	J <sub>XAUITOL</sub>			0.65	UI <sub>p-p</sub>
<b>XAUI Output AC Characteristics (RXLANE[0..3])</b>					
Baud Rate Fibre Channel Ethernet	R <sub>XAUIOUT</sub>		3.1875 3.125		Gbit/s
Baud Rate Variation	R <sub>XAUIVAR</sub>	-100		100	ppm
XAUI Eye Mask (far-end)	According to IEEE 802.3ae and 10G Fibre Channel				
Output Differential Skew	t <sub>SKEWOUT</sub>			15	ps
Output Differential Impedance	Z <sub>OUTXAUI</sub>	80	100	120	Ω
Differential Output Return Loss <sup>1)</sup>	S <sub>22</sub>	10			dB
Total Jitter <sup>4)</sup>	TJ <sub>XAUI</sub>			0.35	UI
Deterministic Jitter <sup>4)</sup>	DJ <sub>XAUI</sub>			0.37	UI
<b>Power-On Reset AC Characteristics</b>					
Power-On Reset and TX_ONOFF Characteristics	According to XENPAK MSA Issue 3.0, 2002-9-18				
<b>MDIO I/O AC Characteristics (MDIO; MDC)</b>					
MDIO Data Hold Time	t <sub>HOLD</sub>	10			ns
MDIO Data Setup Time	t <sub>SU</sub>	10			ns
Delay from MDC Rising Edge to MDIO Data Change	t <sub>DELAY</sub>			300	ns
MDC Clock Rate	f <sub>MAX</sub>			2.5	MHz

<sup>1)</sup> 100 MHz to 2.5 GHz.<sup>2)</sup> At crossing point.<sup>3)</sup> Per IEEE Std 802.3ae.<sup>4)</sup> At near-end, No pre-equalization, 1 UI = 320 ps.

## IV. Optical Characteristics

( $V_{CC5} = 4.75 \text{ V to } 5.25 \text{ V}$ ,  $V_{CC3} = 3.14 \text{ V to } 3.47 \text{ V}$ ,  $V_{CC\text{aps}} = 1.152 \text{ V to } 1.248 \text{ V}$ ,  $T_C = 0^\circ\text{C to } 70^\circ\text{C}$ , BER 1E-12, Bit Rate 10.3125)

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
<b>Transmitter</b>					
Launch Power in OMA <sup>1)</sup>	$P_{O\text{-OMA}}$	-2.8	-1.5		dBm
Average Launch Power	$P_{O\text{-Avg}}$	-5		-1	dBm
TDP	TDP			3.9	dB
Center Wavelength Range <sup>1)</sup>	$\lambda_{C\text{-Tx}}$	840	850	860	nm
RMS Spectral Width <sup>1)</sup>	$\sigma_I$		0.4	0.45	nm
Extinction Ratio	ER	3	5.5		dB
Relative Intensity Noise <sub>12</sub> OMA	RIN			-128	dB/Hz
Eye Mask Definition	According to IEEE and Fibre Channel				
Encircled Flux	EF	at $19 \mu\text{m} \geq 86\%$ , at $4.5 \mu\text{m} \leq 30\%$			
Optical Return Loss Tolerance	$ORL_T$			12	dB
Average Launch Power of OFF Transmitter	$P_{O\text{-OFF}}$			-30	dBm
<b>Receiver</b>					
Stressed Receiver Sensitivity in OMA	$P_{IN\text{-S}}$			-7.5	dBm
Receiver Sensitivity in OMA <sup>2)</sup>	$P_{IN}$			-11.1	dBm
Average Receive Power	$P_{IN\text{-max}}$			-1	dBm
Signal Detect Deassert Level	$P_{SDL}$			-14.5	dBm
Signal Detect Assert Level	$P_{SD}$	-18.0			dBm
Signal Detect Hysteresis	$P_{SD}$	0.5	1.5		dB
Receiver Reflectance	$REF_{RX}$			-12	dB
Center Wavelength Range	$\lambda_{C\text{-RX}}$	840		860	nm

<sup>1)</sup> Conforms to IEEE triple trade-off between center wavelength, RMS spectral width and minimum OMA.

<sup>2)</sup> Receiver sensitivity, which is defined for an ideal input signal is informative only.

## V. General Specifications

### Optical Interface Standard Specifications

Standard	Fiber Type	Minimum Modal Bandwidth at 850 nm (MHz*km)	Operating Range <sup>1)</sup> (meters)
IEEE	62.5 $\mu\text{m}$ MMF	160	2 to 26
	50 $\mu\text{m}$ MMF	400	2 to 66
Fibre Channel	62.5 $\mu\text{m}$ MMF	200	0.5 to 33
	50 $\mu\text{m}$ MMF	500	0.5 to 82
	50 $\mu\text{m}$ MMF	2000	0.5 to 300

Notes:

1) Operating range as defined by IEEE and Fibre Channel standards. Longer reach possible depending upon link implementation.

## Environmental Performance

Operating case temperature: 0°C to +70°C  
 Operating humidity: 0% -95% RH non-condensing

## Fibers and Connectors

The transponder has SC receptacles for both Tx and Rx. The transponder is designed for multimode SC cables, 0° polished endface (PC).

## 70-pin Connector

The module interface connector is a 70-pin, printed circuit board edge connection with a 0.5 mm pitch. The appropriate mating connector for the customer PCB is a 70-pin SMT, dual row, right angled, edge connector, 0.5 mm pitch (Tyco Electronics part number 1367337-1, Molex part number 74441-0003 or equivalent).

## Rail and Mechanical Mounting Requirements

The X2 rail system required to mount the X2 module is fully defined by the MSA. (Tyco Electronics part number 1367608-1: designed for belly to belly applications; and 1367610-1, designed for single sided board mount to fit into the standard host PCB footprint; or equivalent). For further details please refer to vendor-supplied information.

## Aqueous Wash

Finisar X2 transponders are neither solderable nor aqueous washable and are not intended for these processes.

## VI. Regulatory Compliance

Feature	Standard	Comments
ESD: Electrostatic Discharge to the Electrical Pins (HBM)	EIA/JESD22-A114-B (MIL-STD 883D Method 3015.7)	Class 1a (> 500 V)
Immunity: Against Electrostatic Discharge (ESD) to the Module Receptacle	EN 61000-4-2 IEC 61000-4-2	Discharges ranging from $\pm 2$ kV to $\pm 25$ kV to the front end / faceplate / receptacle cause no damage to module (under recommended conditions).
Immunity: Against Radio Frequency Electromagnetic Field	EN 61000-4-3 IEC 61000-4-3	With a field strength of 10 V/m, noise frequency ranges from 10 MHz to 2 GHz. No effect on module performance between the specification limits.
Emission: Electromagnetic Interference (EMI)	FCC 47 CFR Part 15, Class B EN 55022 Class B CISPR 22	Noise frequency range: 30 MHz to 40 GHz Radiated emission does not exceed specified limits when measured with module inside a shielding enclosure with a MSA conforming cutout.



## Eye Safety

Finisar FTLX8541 transponders are Class 1 Laser Products. They are certified per the following standards:

Feature	Agency	Standard	Certificate Number
Laser Eye Safety	FDA/CDRH	CDRH 21 CFR 1040 and Laser Notice 50	9210176-77
Laser Eye Safety	TÜV	EN 60825-1: 1994+A11:1996+A2:2001 IEC 60825-1: 1993+A1:1997+A2:2001 IEC 60825-2: 2000, Edition 2	R 72052602
Electrical Safety	TÜV	EN 60950	R 72052602
Electrical Safety	UL/CSA	CLASS 3862.07 CLASS 3862.87	1439230

Copies of the referenced certificates will be available at Finisar Corporation upon request.

## VII. DOM Parameters

Parameter	Values			Unit
	min.	typ.	max.	
Transponder Temperature Monitor Accuracy <sup>1)</sup>	-5		+5	°C
Laser Bias Current Monitor Accuracy <sup>2)</sup>	-10		+10	%
Transmit Power Monitor Accuracy <sup>3)</sup>	-3		+3	dB
Receive Power Monitor Accuracy <sup>3)</sup>	-3		+3	dB

<sup>1)</sup> 0 to 70°C case temperature.

<sup>2)</sup> 0 to 12.5 mA.

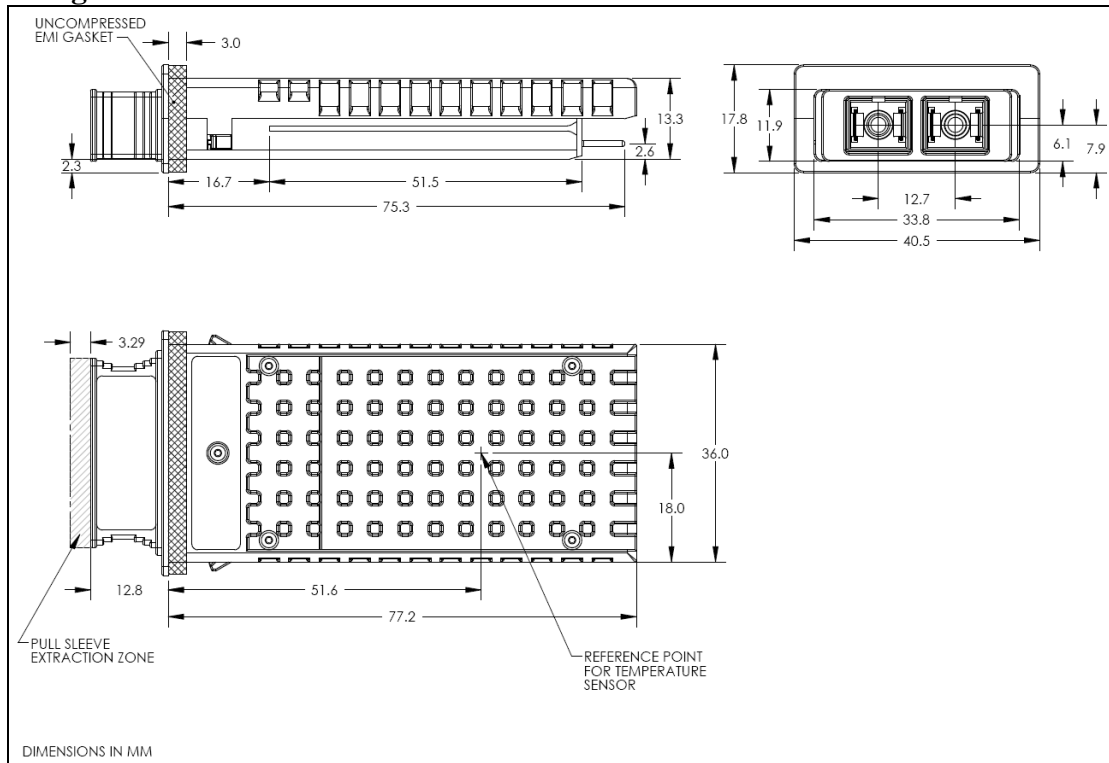
<sup>3)</sup> -8.2 dBm to +0.5 dBm.

## VIII. Mechanical Specifications

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Module Retention Force (latch strength)	F <sub>RET</sub>		200		N
Module Insertion Force	F <sub>IN</sub>		40		N
Module Extraction Force (with kick-out)	F <sub>EXT-K</sub>		16		N
Module Extraction Force (without kick-out)	F <sub>EXT</sub>		25		N

Pull Sleeve front face color is beige.

## Package Outline



**Figure 2 - X2 Mechanical Dimensions**

## IX. References

### Optical Interface Standard Specifications References

- IEEE Std 802.3ae-2002 clause 52, 10GBASE-SR
- Fibre Channel 10GFC Draft 4.0, 1200-M5-SN-I
- Fibre Channel 10GFC Draft 4.0, 1200-M5E-SN-I
- Fibre Channel 10GFC Draft 4.0, 1200-M6-SN-I
- X2 MSA Issue 2.0b

### Electrical Interface Standard Specifications References

- IEEE Std 802.3ae-2002 clause 45 & 47
- X2 MSA Issue 2.0b

## X. For More Information

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