User's Manual
Model: ***TT360XYZ***
Angle Monitor

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Introduction:

The Mathews Engineering TT360XYZ angle monitor is a precision angle indicator capable of monitoring rotation in any of the three X, Y, or Z directions. The display graticule can be tailored to most any preference with convenient touch screen controls. The TT360XYZ works with a remote sensor appropriate for use with sheet metal box and pan brakes and other machinery where a precise indication of angle is required. Both the display box and the remote sensor come with magnetic mounting pads for rapid installation. The TT360XYZ also has a 9-pin RS-232 port allowing integration into systems that require external control and data retrieval.

Applications:

- Bend angle display for sheet metal pan and box brakes
- Forklift mast angle display
- Construction, robotics, and automation

Features:

Figure 1: Features

Features:

1) **Full color touch screen:**
   - 2.8" color touch screen
   - 320x240 resolution RTP (resistive touch panel)
   - 65536 colors
   - Will work when operator is wearing gloves

2) **Power Input Jack:**
   - 5V input voltage
   - 5.5x2.1mm type, center positive

3) **ON/OFF Switch**
   ON Position: Normal operation
   OFF Position: The unit is OFF. The TT360XYZ has non-volatile memory and will remember your prior settings even if power is removed or when switched OFF.

4) **Sensor input jack:**
   High quality 5 pin aviation connector with threaded locking collar

   Warning! I/O pins may be ESD sensitive.
   Avoid direct ESD discharge to the pins of this connector.

5) **RS-232 9-pin I/O port:**
   - PC compatible I/O port
   - Meets TIA/EIA-232-F requirements

6) **Magnetic Mounting Pads:**
   - Strong rubber coated magnets
   - Display magnet's screw thread: M4x0.7

Other Features:
   - Settings and calibration are held in non-volatile memory
   - Magnetic display head and magnetic sensor for an easy "no drilling" installation
   - Full "four quadrant" math means that there are no disjoint measurement issues
   - Mounting magnets can be removed for applications where screw mount is preferred

Accessories (included):

Figure 2: 5V Power Adapter

Figure 3: Moisture Resistant Sensor
SNSR360

Specifications:

	Calibration: ON, Ta = 0C to 40C			
	MIN	TYP	MAX	UNIT
Input 5.5x2.1mm (ctr pos)	4.75	5.0	16.0	V
Reverse Voltage Protection	-42			V
Display Size		2.8		Inch
Display Resolution		320x240		
Display Type		Resistive Touch		
Display Colors		65536		
Sensor Type		3-axis Accelerometer		
X-Axis Accuracy		0.25° rms	+/-1°	Deg.
Y-Axis Accuracy		0.25° rms	+/-1°	Deg.
Z-Axis Accuracy		0.35° rms	+/-1.5°	Deg.
Repeatability		0.2°		Deg.
RS-232 Port		TIA/EIA-232-F		
RS-232 Output Levels		+/-5.4	+/-5	V
RS-232 Input Levels	+/-1.5		+/-25	V
RS-232 Port (IC data)		MAX3232, Vcc= 3.3V		
RS-232 Connection		DB9(f), 3-wire type		
RS-232 Port ESD			+/-15	kV
RS-232 Cable Drive Capability	100			feet
SNSR360 Wire Length		2		m
TT360XYZ Case		115x66x43		mm
SNSR360 Case		57x25x23		mm

Sensor Placement:

Before placing the sensor, prior consideration of the desired measuring axis is recommended.

The positive direction of each axis is identified by the arrows on the top of the SNSR360. The Z-axis "dot" indicates that the Z-axis arrow points "out of the page".

The "right hand rule", shown here in figure 4, indicates which angle will be measured when any particular axis is selected. Application of the right hand rule to the X-Axis is shown in figure 4. Similar logic applies to the Y and Z axes.

The accuracy of the X and Y axis is slightly better than the Z-axis so, when possible, use the X or Y measurement axis.

SNSR360 is an acceleration type sensor. As such, use in applications with high levels of vibration is not recommended as this will negatively affect measurement accuracy.
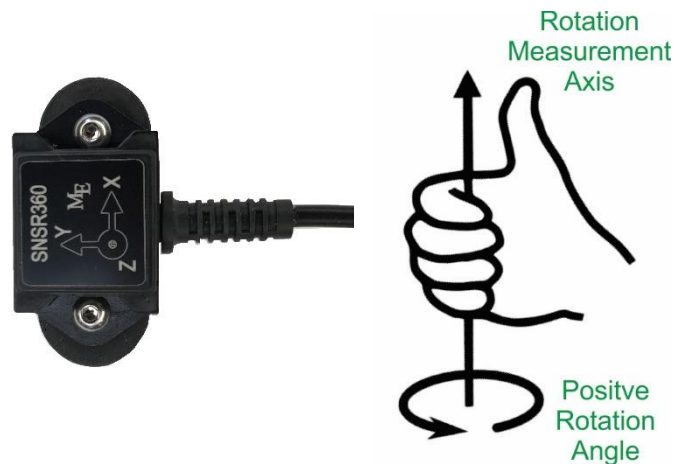

Figure 4: EXAMPLE: X-Axis Orientation by Right Hand Rule

Place the SNSR360 on the item to measure (bending leaf, forklift mast, etc.). For easy installation the SNSR360 is supplied with rubber coated magnetic mounting pads. For applications where a more permanent installation is desired, or where a magnetic surface is not available, remove the magnets to access the SNSR360 screw mounting flange.

Route and secure the sensor wire with wire ties and protect the sensor wire from damage caused by the full range of your machine's motion. Leave an appropriate amount of loose wire and make sure the sensor is not tugged upon when anywhere within its expected range of motion.

Operation:

To re-locate the zero angle, touch any one of the four locations shown here:
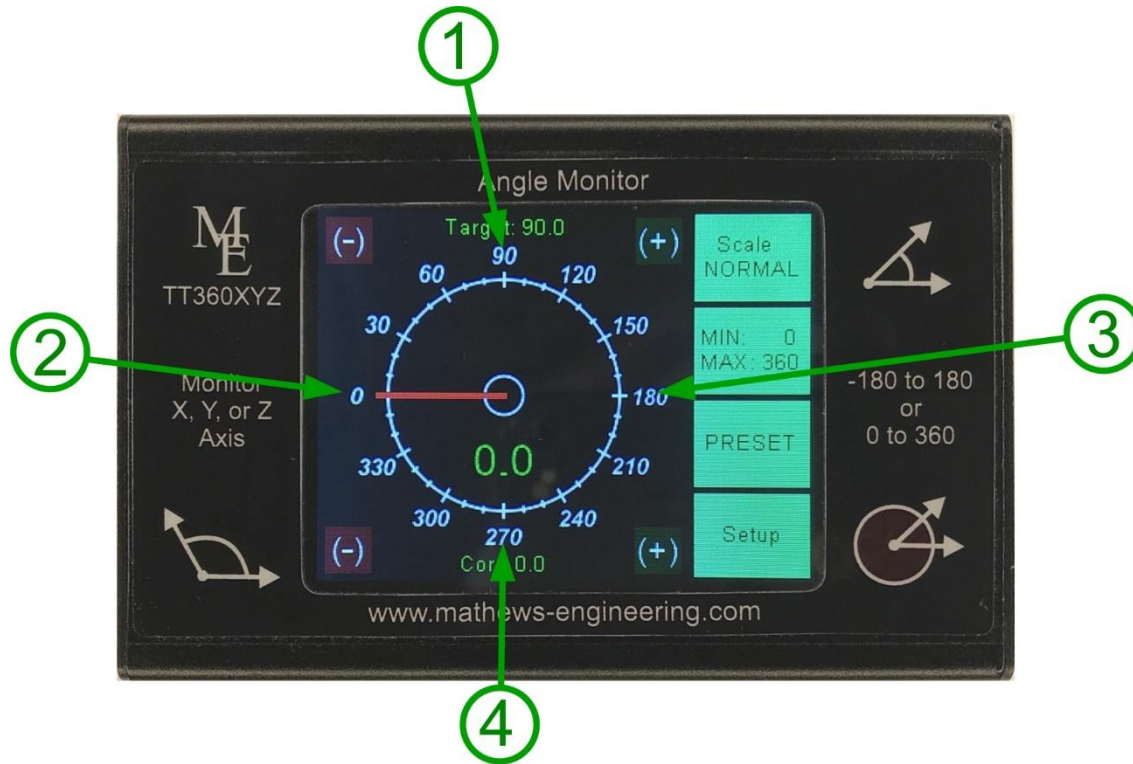
The main screen has four buttons. They are:

5) Scale NORMAL/INVERT:
      NORMAL: Increasing angles display in the CW direction
      INVERT: Increasing angles display in the CCW direction

6) MIN MAX:

0 to 360:   The display range is from 0 to 360 degrees
-180 to 180:   The display range is from -180 to 180 degrees

In all cases, angles that fall outside of the selected range will continue to be displayed correctly mapped into the selected range. The correct angle will always be displayed and there is no limit to how many times the angle can pass over or under the display limit.

7) PRESET:

The PRESET button returns all settings to the factory default.
Preset does not affect the sensor calibration.
After pressing PRESET the settings will be:

Zero location:	LEFT
Scale:	NORMAL
MIN/MAX:	0-360
Target:	90.0
Corr:	0.0
Rotation Measurment Axis:	X-Axis
Direction of Zero Angle:	Z+
Invert Rotation:	OFF

8) SETUP:

Press this button to enter the setup screen.

The main screen also has two user settable parameters:

9) Target:

Press the green (+) or red (-) to increase or decrease the target angle by 0.1 degree. Hold down the (+) or (-) button to move rapidly to the desired value. The valid range for the target is -180 to 359.9 but is also limited by the selected scale. When the measured angle is within +/- 10 degrees of the target a vertical progress bar will show up (see item 11 below).

10) Corr:

Press the green (+) or red (-) to increase or decrease the correction value by 0.1 degree. Hold down the (+) or (-) button to move rapidly to the desired correction value. The positive or negative correction value is added to the measurement. Use this feature to correct for sheet metal "spring back", sensor placement, or other application specific errors.

Target Feature:

11) Target Feature:

The target feature is active whenever the measured angle is within +/-10 degrees of the target setting. The green "magnification bar" will appear to help the press brake operator more precisely hit the desired target angle. When the green target bar is exactly abeam the left graticule then the measured angle equals the target.

Setup Screen:

Display settings only affect how the angle is displayed. On the other hand, the setup screen determines exactly which angle is measured and how the zero angle should be oriented.
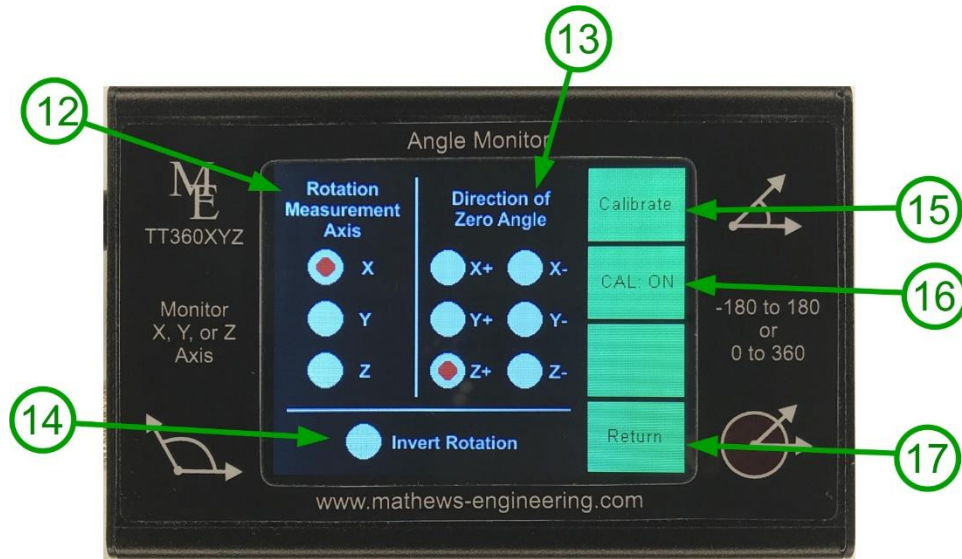
12) Rotation Measurement Axis:

Select X, Y, or Z as the measurement axis. For highest accuracy, use the X or Y axis.

For reference, each axis, and its associated orientation, is placarded on the lid of the SNSR360 remote sensor.

13) Direction of Zero Angle:

Select the desired direction of the zero angle. The zero angle must be perpendicular to the Rotation Measurement Axis. As such, the direction vectors for the currently selected axis will be greyed out. If the Rotation Measurement Axis is changed to an axis that is not perpendicular then a new and appropriate "Direction of Zero Angle" will be automatically selected.

14) Invert Rotation:

Normally all TT360XYZ measurements obey the "right hand rule". That is positive angles are registered when rotation follows the direction of fingers on your right hand. When "Invert Rotation" is ON, this relationship is inverted.
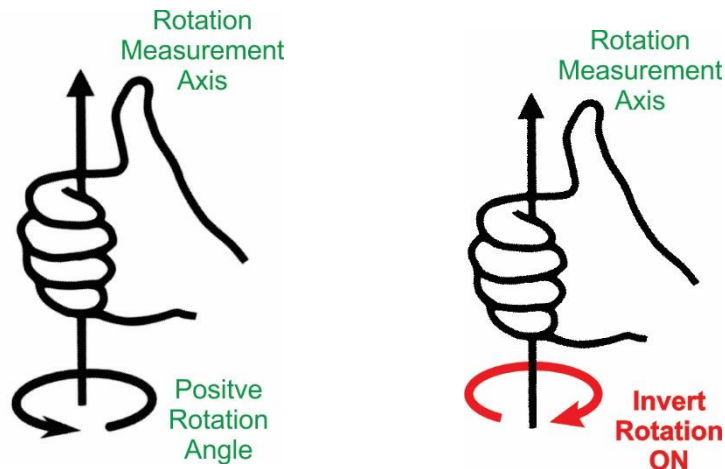
15) Calibrate:

TT360XYZ is calibrated at the factory. The calibration factors are stored in non-volatile memory and normally do not need to be changed. In the event that a field calibration is desired, the calibration buttons are accessed here.
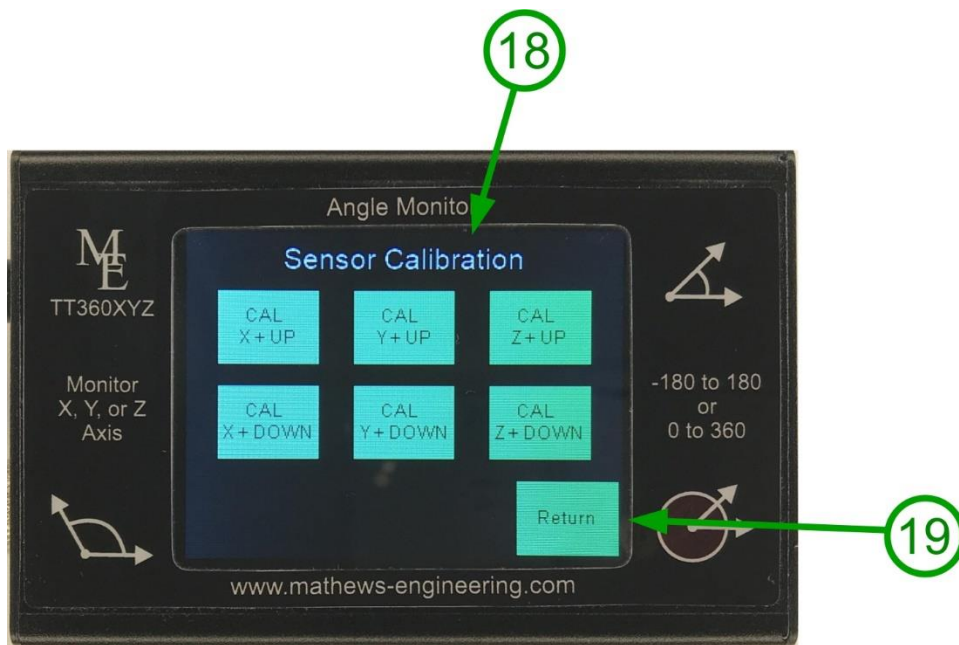
16) CAL ON:

Except for testing or evaluation the calibration should always be left in the ON position.

17) Return:

Returns to the main screen.

The Sensor Calibration screen has six calibration buttons:

18) Calibration Buttons:

When the TT360XYZ is working normally, there is no need to perform a calibration. Calibration is factory set and is held in non-volatile memory.

In the event that a field calibration is desired, the SNSR360 sensor should be placed on a known level surface and carefully rotated into each of the six orientations. 90 degree angle plates should be used for X and Y axis calibration. After each calibration orientation is established, the CAL button for that associated direction should be pressed. After all six axes are calibrated, press the return button (19).

19) Return:

Returns to the main menu.

Remote Operation (RS-232):

The TT360XYZ can be remotely controlled through its 9-pin RS-232 port.

To connect to the TT360XYZ from a computer use these RS-232 settings:

Baud: 115200
Parity: None
Data Bits: 8
Stop Bits: 1
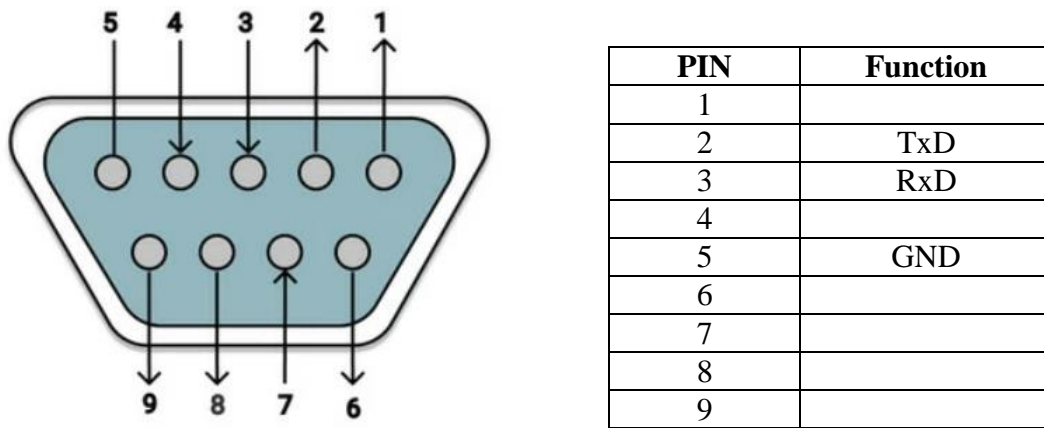Flow Control: XON/XOFF
Standard: TIA/EIA-232-F

PIN	Function
1	
2	TxD
3	RxD
4	
5	GND
6	
7	
8	
9	

*Figure 5: 9-Pin Female D-Connector Pinout*

CABLE:

The typical PC connection requires a DB-9 male to female RS-232 cable with all pins connected one-to-one however this is a 3-wire connection so only pins 2,3, and 5 are used.

In the event a one-to-one cable does not work, a null modem adapter (reverses pins 2 and 3) may be required. The maximum recommended cable length is 100 feet.

**Example setup using the widely available PuTTy Terminal program:**

If not already known, use windows device manager to determine which COM port to use.

Use PuTTy or other terminal application to test the communications link. The TT360XYZ can also be controlled and automated using this same RS-232 protocol through popular programming languages such as Python, Basic, C, C++, etc.
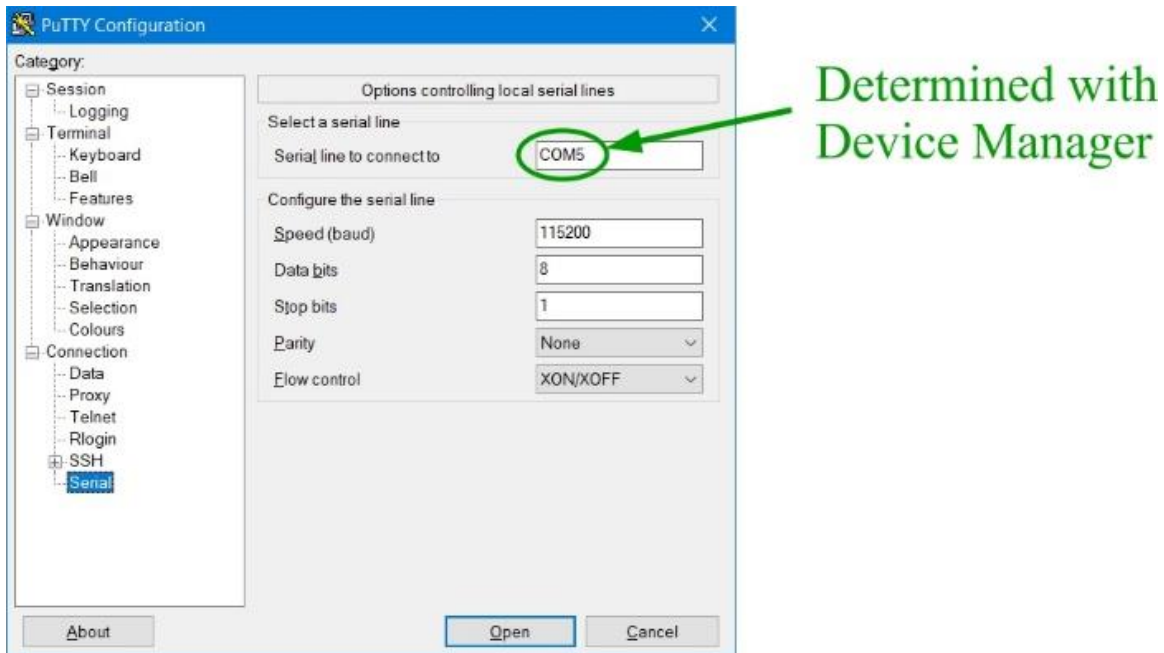
Simple PuTTy Session Example:

For a quick check, send the "?" command and the TT360XYZ will identify itself.
The see the most recently displayed angle send the "angle?" command.
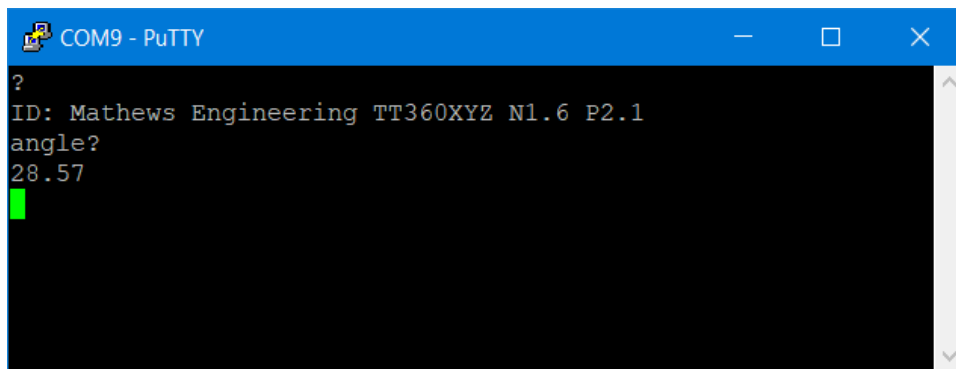
All commands to the TT360XYZ should end with a carriage return CR (ASCII 13).
Commands may be sent as upper or lower case.

COMMAND	Result	Reply	Range
?	ID string and software versions	string	
angle?	Most recent displayed angle	XXX.XX	-180.0 to 360.0
axis x	Set the measuring axis to x		
axis y	Set the measuring axis to y		
axis z	Set the measuring axis to z		
dir x+	Sets the zero angle to x+		(axis must be y or z)
dir x-	Sets the zero angle to x-		(axis must be y or z)
dir y+	Sets the zero angle to y+		(axis must be x or z)
dir y-	Sets the zero angle to y-		(axis must be x or z)
dir z+	Sets the zero angle to z+		(axis must be x or y)
dir z-	Sets the zero angle to z-		(axis must be x or y)
invert ON	Sets rotation direction to inverted		
invert OFF	Sets rotation direction to normal		
target XXX.X	Sets the target value		-180.0 to 359.9
corr XXX.X	Sets the correction factor		-90.0 to 90.0
scale normal	Sets the display scale to un-inverted		
scale invert	Inverts the display scale		
max 180	Sets the -180 to 180 scale range		
max 360	Sets the 0 to 360 scale range		
zero left	Sets the zero location to the left		
zero right	Sets the zero location to the right		
zero top	Sets the zero location to the top		
zero bottom	Sets the zero location to the bottom		
cal ON	Turn sensor calibration ON		recommend always leave cal ON
cal OFF	Turn sensor calibration OFF		
preset	preset all settings to factory default		
(OTHER)	Returns an error message	string	ERROR: Unknown Command: ""

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