FAIRCHILD MODEL T9000 SERIES ELECTRONIC PRESSURE CONTROLLERS (Analog Output) Operation and Maintenance Instructions Software Version 3.47

Figure 1. Model T9000 Keypad

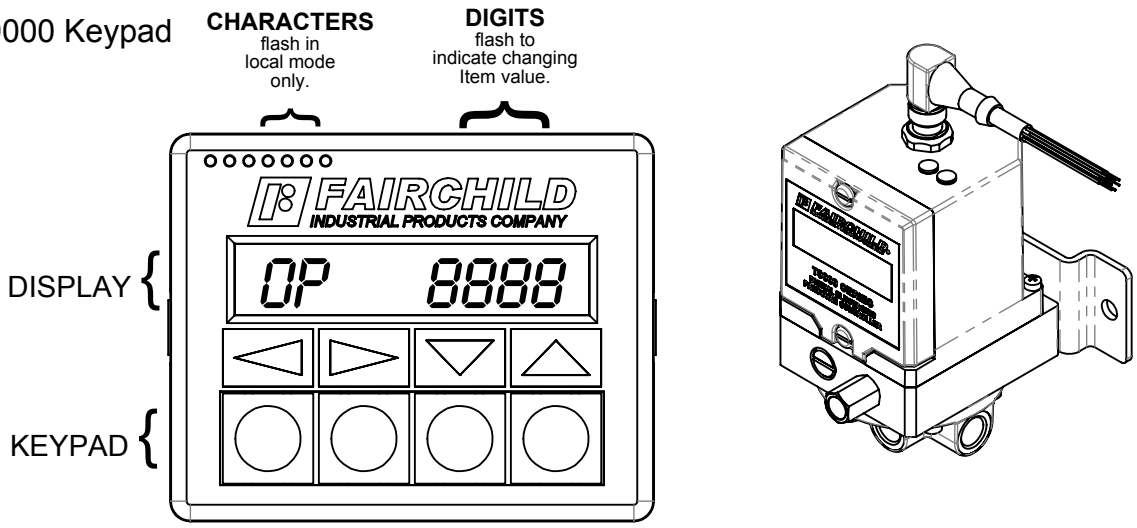

Figure 2. Model T9000 Series Pressure Controller Keypad Functions

	Main menu/Sub-menu items (digits not blinking)	**Item value (digits blinking)**
▲	Go to previous menu item.	Go to previous item value.
▼	Go next menu item.	Go to next item value.
►	Go to Sub-menu. Select item value to change, starts blinking.	Accepts new value. (ENTER) Stops blinking.
◄	Go to OP .	Does not accept new value. (ESC) Stops blinking.

GENERAL INFORMATION

The Model T9000 Series Electronic Pressure Controllers use feed and bleed solenoid valve control technology, digital feedback electronic control, and an internal electronic pressure sensor to achieve high accuracy pressure control. Keypad and display with intuitive detailed menu with flexible configuration and PID tuning capability ensure that these pressure controllers can meet the most demanding air pressure control applications. Commissioning, quality control, and troubleshooting functions are made easy using the T9000's numerous input and output monitoring features.

FEATURES AND CAPABILITIES

CAPABILITIES

Control the setpoint remotely by proportional voltage or current signal
Control the setpoint locally using the keypad and display
Display output pressure/setpoint in any pressure units
Display output/setpoint in any process units proportional to output pressure
Control pressure at a remote process location using remote pressure sense port
Control process variable from electronic analog input option (configurable in volt or mA)
Monitor output using analog output option (configurable in volt or mA)
Control analog output locally from keypad
Wide range of calibration flexibility

FEATURES

Feed & bleed pressure control technology
Maintains output pressure upon loss of power (Fail in place version)
Relieves output pressure upon loss of power (Fail low version)
Keypad and backlit LCD display with intuitive detailed menu
Numerous flow ranges available
Numerous port sizes and port thread types available
Low air consumption
Tapped exhaust captures both booster and pilot exhaust
Pilot section filter
NEMA 4/IP65 enclosure
Pilot section relief valve limits output pressure on low pressure units

SPECIFICATIONS	
PARAMETER	**VALUE**
ELECTRICAL	
Supply Voltage	11-24 VDC
Power Consumption	Less Than 4 Watts
Control Input Range	
mA	0-24 mA
Volt	0-12 volt
Control Input Impedance	
mA	246 ohms
Volt	500K ohms
Maximum Control Input	
mA	35 mA without damage
Volt	Volatge input clamped at 13 vdc
Analig Output Load Impedance	
mA	500 ohms Maximum
Volt	400 ohms Minimum
PNEUMATIC	
Maximum Supply Pressure	200 psig
Minimum Supply Pressure	5 psig above max output
Output Pressure Ranges	0-30 psig
	0-75 psig
	0-150 psig
Forward Flow Capacity	(@ 150 psig supply)
T9000	1 scfm
T9010	12 scfm
T9020	90 scfm
T9040	111 scfm
T9060	220 scfm
T9080	700 scfm
Exhaust Flow Capacity	(@ 60 psig setpoint)
T9000	0.5 scfm
T9010	4 scfm
T9020	45 scfm
T9040	55 scfm
T9060	110 scfm
T9080	350 scfm
Air Quality	Per ISA S7.0.01
ENVIRONMENTAL	
Ingress Protection	NEMA 4 & IP65
Operating Temperature Range	0-160 °F

T9000 SERIES MENU SYSTEM WITH ANALOG OUTPUT OPTION

Table 1. Main Menu

Item	Description	Range
OP	**Output Pressure**- Displays the actual output pressure.	0-30 psig, [0-2 BAR], (0-200kPa) 0-75 psig, [0-5 BAR], (0-500kPa) 0-150 psig, [0-10BAR], (0-1000kPa)
SP	**Setpoint** - Sets/displays the required pressure setpoint.	0-30 psig, [0-2 BAR], (0-200kPa) 0-75 psig, [0-5 BAR], (0-500kPa) 0-150 psig, [0-10BAR], (0-1000kPa)
CV	**Control Value** - Displays control input value.	0-24mA or 0-12 VDC
OV	**Option Value** - Displays the feedback option output value.	0-24mA or 0-12 VDC
S	**Setup Menu** - Accesses the Setup Menu.	See Table 2.
C	**Calibration Menu** - Accesses the Calibration Menu.	See Table 3.
T	**Tuning Menu** - Accesses the Tuning Menu.	See Table 4
OC	**Output Control** - Sets the mode of operation for the analog output.	OP or USEr
LR	**Control Input** - Sets the mode of operation for the control input.	Remote or Local

Table 2. Setup Menu (Option S on the Main Menu)

Item	Description	Range
CU	**Control Units** - Sets the operating units for control input.	mA or VDC
OU	**Option Units** - Sets the operating units for the analog output.	mA or VDC
EQ	**Look Ahead Function** - [1] Improves setpoint accuracy and response time.	Enable or Disable
N/	**Numerator** - Sets/displays pressure unit conversion factor.	0-9999
/D	**Denominator** - Sets/displays pressure unit conversion factor.	0-9999

Table 3. Configuration Menu (Option C on the Main Menu)

Item	Description	Range
P1	**Output pressure 1** - Sets the output pressure required at control setpoint C1. Typically 0%	0-30 psig, [0-2 BAR], (0-200kPa) 0-75 psig, [0-5 BAR], (0-500kPa) 0-150 psig, [0-10BAR], (0-1000kPa)
P2	**Output pressure 2** - Sets the output pressure required at control setpoint C2. Typically 100%	0-30 psig, [0-2 BAR], (0-200kPa) 0-75 psig, [0-5 BAR], (0-500kPa) 0-150 psig, [0-10BAR], (0-1000kPa)
C1	**Control Value 1** - Sets the 0% Control Input value.	0-24 mA - 0-12 VDC
C2	**Control Value 2** - Sets the 100% Control Input value.	0-24 mA - 0-12 VDC
O1	**Option 1** - Sets the desired value of the analog output at output pressure value P1	0-24 mA - 0-12 VDC
O2	**Option 2** - Sets the desired value of the analog output at output pressure value P2	0-24 mA - 0-12 VDC
L1	[2] Records the low pressure look ahead coefficient.	10% of full scale
L2	[2] Records the high pressure look ahead coefficient.	90% of full scale

Table 4. Tuning Menu (Option T on the Main Menu)

Item	Description	Range
KP	**Proportional** - Sets the proportional gain.	0-63.99
KI	**Integral -** Sets the reset time.	0-9.99 repeats per second
KD	**Derivative -** Sets the rate of change	0 - 6.399 seconds
DB	**Dead Band -** Sets the amount of pressure centered on the setpoint which the unit does not respond.	0-10% maximum pressure (Value displayed in pressure units)

[1] **L1 and L2 must** be set for EQ to work correctly.

[2] Recommend 60% difference in the range (value) between L1 and L2. A **zero** value is **not** recommended.

T9000 OPERATION

Menu Navigation
The T9000 Menu system consists of a main menu and three sub-menus. The main menu contains items for monitoring and control of operating functions and vectors for accessing the sub menus. The three sub menus configure operational Settings (S), Calibration (C), and Tuning (T). See Table 1 through 4 for a list of the T9000 menu system items.

Display Interface
The T9000 display contains a group of two alpha-numeric characters and a group of four numeric characters. The two alpha-numeric characters are mnemonics for the menu items and sub menu vectors. The four numeric characters display the value of the menu item. There is no numeric valve associated with the sub menu vectors.
The T9000 has four buttons to control the menu interface and to enter data. The four button functions, from left to right are as follows: ◄ (Escape or Cancel), ► (Enter), ▼ (Down or Decrease), and ▲ (Up or Increase).
The display will change back to the top level Main Menu item, OP (Output Pressure) 3 minutes after the last button is pressed. If a menu item value is being changed but not entered, the operator can cancel the change by pressing the left most button (Escape or Cancel) and the original value will be retained. Pressing the left most button again will return the menu system to the top level menu item, OP.

Default Operating Mode
The model T9000 ships from the factory configured to control output using the control input as the setpoint control. The analog output is configured to output an analog output signal that is proportional to the output pressure. The factory set control input signal, output pressure range and analog output signal parameters are listed on the nameplate.

Controlling the Output Pressure
The model T9000 ships from the factory configured to control output using the control input as the setpoint control. Connecting a signal source to the control input lines in the range listed on the nameplate and the T9000 will output a pressure proportional to the control input signal value.
The output pressure can also be controlled directly from the keypad by changing to Local mode. In this mode the T9000 does not respond to the control input signal but is controlled by changing the setpoint from the keypad. The T9000 can be used as an electronic pressure regulator while in Local mode.

Local mode is activated by setting the LR menu item in the Main Menu to LOCL. To set the T9000 in Local mode, use the Up or Down button to scroll to the LR menu item in the Main menu and press the enter button. Use the Up or Down button and scroll to display LOCL and press the Enter button. The left two characters of the display will flash on and off indicating the T9000 is in the Local operating mode. The output pressure setpoint is set by entering the Setpoint from the SP (Setpoint) menu item in the Main Menu. Use the Up or Down button to scroll to SP in the Main Menu and press the Enter button. Use the Up or Down button to change to a new setpoint value then press the Enter button to accept the new value. When changing from Remote mode, the Local mode will start at the last Remote mode setpoint to provide a bumpless transfer from Remote mode to local mode. To set the T9000 to control the setpoint remotely using the control input signal (Remote mode), from the Main Menu, use the Up or Down button to scroll to the LR menu item and press the Enter button. Use the Up or Down button to change the menu value to RENN and press the Enter button.

Controlling the Analog Output
The T9000 ships from the factory with the Analog Output configured to output an analog output signal that is proportional to the output pressure. The Analog Output will output a signal to the Analog Output lines in proportion to Output Pressure according to the values of Output Pressure Range and Analog Output listed on the label.
The Analog Output can also be controlled directly from the keypad by changing the Analog Output to local control. This is achieved by setting the OC menu item in the Main Menu to USER (User). In Local control, the Analog Output is set by changing the value of OV (Option Value) in the Main Menu. Use the Up or Down button to scroll to OV in the Main Menu and press the Enter button. Use the Up or Down button to change to a new Analog Output value then press the Enter button to accept the new value. The OV menu item displays the current Analog Output value in either Output Pressure or Local operating modes. When changing from Output Pressure mode, the Local mode will start at the last Output Pressure setpoint to provide a bumpless transfer from Output Pressure mode to local mode.

Table 5: Quick Setup				
T9000 Configuration Settings for Operating Modes for Software Versions starting at V3.45				
T7900 Configuration	LR=LOCL OC=USER	LR=REM OC=USER	LR=REM OC=OP	LR=LOCL OC=OP
Operating Mode	SP (Keypad) Controls Output OP Keypad Controls OV	CV Controls Output OP Keypad Controls OV	CV Controls Output OP OV Follows OP	SP (Keypad) Controls Output OP OV follows OP

LR Control Input Mode Switch Alpha characters blink in LOCL mode

T9000 SETUP

The Setup menu items configure the various interface parameters of the T9000 such as the Control Input and Analog Output units as well as what is displayed by the top level menu item, OP. To enter the Setup Menu, from the Main Menu, use the Up or Down buttons to scroll to the S menu item vector and press the Enter button. Use the Up and Down buttons to scroll through the Setup Menu items. See Table 2 for a list of the Setup menu items.

Control Input Units

The Control Units (CU) menu item sets the control input units to the T9000 to either voltage or milliamps. After entering the Setup Menu S, use the Up or Down button to scroll to the menu item CU (Control Units) and press the Enter button. Use the Up or Down button to select MA for a milliamp Control Input signal or VOLT for a voltage Control Input signal. See table 1 for the Control Input signal limits.

Analog Output Units

The Option Units (OU) menu item sets the analog output units for the T9000 to either voltage or milliamps. After entering the Setup Menu S, use the Up or Down button to scroll to the menu item OU (Option Units) and press Enter. Use the Up or Down button and select MA for a milliamp Analog Output signal or VOLT for a voltage analog output signal. See table 1 for the Analog Output signal limits.

Look Ahead Function

The Look Ahead (EQ) feature functions as a feed forward function and predicts the internal correction needed to produce the desired output. This is helpful in PID feedback controlled systems to reduce the steady state offset error and the dependency on the Integral term to drive the output error to zero. To enable or disable this feature, enter the Setup Menu S, Then use the Up or Down button to scroll to the menu item EQ (Look Ahead Function) and press Enter. Use the Up or Down button and select ENAB (Enable) or DIS (Disable). This function relies on proper setting of menu items L1 and L2 in the calibration menu to operate correctly. See instruction for setting L1 and L2 in the T9000 CALIBRATION section. The T9000 ships from the factory with this feature enabled.

Output Pressure Units

Setup menu items N/ and /D enables the T9000 to display virtually any linear output pressure units. N/ and /D form the numerator and denominator of a conversion factor that converts the T9000's base units of pressure (pounds per square inch or psi) into the desired units of pressure. See table 6 for values of N/ and /D for some common units of pressure. In addition, these two menu items can also be used to configure the T9000 to display any process units that are directly proportional to the output pressure. For example, if the T9000 controls the pressure to an air cylinder, the T9000 can be configured to display the output in terms of force instead of pressure.

From the Main Menu, enter the Setup Menu S, use the Up or Down button to scroll to the menu item N/ (Numerator) and press Enter. Use the Up or Down button to set the desire number for the numerator of the conversion factor and then press the Enter button to accept the new value. Repeat the process for entering the value for the /D (Denominator) value. Note that Main Menu items, OP and SP, Calibration Menu items P1 and P2, and Tuning Menu item DB will all display in terms of the new pressure units.

Table 6: Common Pressure Unit Conversions			
Pressure Unit	N/	/D	**Comments**
psig	1	1	Psig=psig x 1
Bar	100	1451	Bar=psig x 0.0689
kPa	6895	1000	kPa=psig x 6.895
InHg	5000	2456	InHg=psig x 2.036

T9000 CALIBRATION

The Calibration menu items allow the user to change the relationship of the control input signal to output pressure and output pressure to the analog output signal of the T9000. To enter the Calibration Menu, from the Main Menu, use the Up or Down buttons to scroll to the C menu vector and press the Enter button. Use the Up and Down buttons to scroll through the Calibration menu items. See Table 3 for the list of Calibration Menu items.

Control Input/Output Pressure Calibration
When in remote mode, the T9000 pressure controller will produce an output pressure in response to a control input signal according to the values set in Calibration menu items P1, P2, C1 and C2. The values in these menu items establish a pair of cardinal points of the Control Input to Output Pressure proportional relationship.
Menu items P1 and C1 have a unique association as well as P2, and C2. Menu items P1 and C1 establish a low point calibration reference where the T9000 will produce the output pressure set in P1 when the control input signal is at the value set in C1. Likewise, the P2 and C2 menu items establish the high point calibration reference. The T9000 will then produce a proportional output pressure between the values set in P1 and P2 for a control signal that varies between C1 and C2. For example: if the desired output pressure range is 10 to 90 psig as the control input varies from 4 to 20 milliamp, then the values of P1, P2, C1 & C2 are entered as in the table 7 below.

Menu Item	Value	Menu Item	Value
P1	10.00	C1	4.00
P2	90.00	C2	20.00

Output Pressure /Analog Output Calibration
The signal produced by the Analog Output lines is related to the values set in P1, P2, 01 and 02. Menu items P1 and 01 establish a low point calibration reference where the T9000 will produce the analog output signal set in 01 when the output pressure is at the value set in P1. Likewise, the P2 and 02 menu items establish the high point calibration reference. For example: if the desired analog output signal range is 6 to 16 milliamps as the output pressure varies from 10 to 90 psi, then the values of P1, P2, 01 & 02 are entered as in the table 8 below.

Menu Item	Value	Menu Item	Value
P1	10.00	C1	6.00
P2	90.00	C2	16.00

Notes:
1. An inverse relationship between the control input and the output pressure can be produced by setting C1 to 20.00 and C2 to 4.00.
2. C1 and C2 cannot contain the same value. (The T9000 cannot produce two different output pressures for the same input signal. The same applies to Menu items P1, P2 and 01, 02.
3. P1 and P2 menu items are associated with C1, C2 and 01, 02. Changing the value of P1 or P2 will affect its relationship with C1, C2 and 01, 02.

Menu Item	Value	Menu Item	Value	Menu Item	Value
C1	4.00	P1	10.00	01	0.00
C2	20.00	P2	90.00	02	10.00

Look Ahead Coefficients
The setting of menu items L1 and L2 characterize the feed & bleed solenoid valves as a function of the supply pressure. L1 and L2 therefore must be set at the supply pressure the T9000 is operated. The L1 and L2 values are set after the T9000 has been calibrated and the supply pressure set to it normal operating value.

Setting Coefficient L1
Input a control signal to produce an output pressure between 10 and 20% of its range. From the Main Menu, use the Up or Down buttons to scroll to the C menu vector and press the Enter button. Use the Up and Down buttons to scroll through the Calibration menu items until the Menu item L1 appears. Momentarily press the Enter button. The display will flash once to indicate the L1 value has been set (there will not be a displayed value).

Setting Coefficient L2
Input a control signal to produce an output pressure between 75 and 90% of its range. From the Main Menu, use the Up or Down buttons to scroll to the **C** menu vector and press the Enter button. Use the Up and Down buttons to scroll through the Calibration menu items until the Menu item L2 appears. Momentarily press the Enter button. The display will flash once to indicate the L1 value has been set (there will not be a displayed value).

Tuning
The T9000 features a PID tuning section with independent Proportional (KP), Integral (KI), and Derivative (KD) tuning coefficients giving the user the ability to accurately adjust the T9000's response characteristics to the process conditions. There is also a deadband adjustment that can be employed to reduce air consumption and extend the life of the solenoid valves in the pilot section. To access the Tuning Menu, from the Main menu, use the Up or Down button and scroll to the T Menu item and press the Enter button. Use the Up and Down button to scroll through the Tuning menu items.

Tuning Coefficients
The T9000 ships from the factory with nominal PID values that will be stable in most systems, however the default tuning values may not provide optimum response characteristics. To access and change the value of these coefficients, after accessing the Tuning menu, use the Up and Down buttons and scroll to the desired tuning coefficient and press the Enter button to change the value. Use the Up and Down buttons to change the value of the coefficient. Press the Enter button to accept the new value. See Table 4 for a list and description of the Tuning menu items. Use the following procedure to determine the appropriate values for the KP, KI & KD tuning coefficients.

1. Start with KP = 1.00, KI = 0.00, KD = 0.000. Set DB to 0.00 while optimizing the KP, KI & KD values. Return DB to the desired value after optimizing the PID coefficients
2. Increment KP by 0.01 or other minimal value. Change the setpoint from 50% to 70% of full scale then change the setpoint back to 50%.
3. If the output stabilizes then continue to repeat step 2 until the output achieves a continuous oscillation.
4. Measure the period of the oscillation (in seconds) and go to step 5.
5. Set KP to 50% of the value that produced the continuous oscillation. Set KI to the period of the oscillation, and set KD to 1/8 of KI.

This procedure will produce a quick response characteristic with minimal overshoot and settling time. After setting the values using this procedure, you can change individual KP, KI, or KD values to achieve the desired response characteristic.

Deadband
The Deadband (DB) function sets the amount of error, centered about the setpoint, for which the T9000 will not take action to correct. While in this "Window" of error, both the feed and bleed solenoid valves will be held in the off or locked state and the pilot section of the T9000 will not consume any air. The T9000 ships from the factory with this value set to 1% of the output pressure range. The value displayed for DB is in the units of the Output Pressure and corresponds to the Output Pressure conversion set by N/ & /D in the Setup Menu. The Deadband value can be set to 0.00 to achieve very high accuracy. When the Deadband set to zero, the pilot section will continuously consume a small amount of air which will be expelled through the exhaust port in the booster section.

Messages
At startup, a message symbols (MG) may briefly appear on the display alerting the operator to a problem. For an explanation of these messages, see Table 7.

Table 7: Messages

Message	Problem	Solution
LO PR	Low Power	Check for low supply voltage
14, 15	Memory is corrupt	Return unit to the factory

Restoring Factory Defaults
To restore factory default values, use the following steps:

1. Scroll to Menu item T
2. Press and hold the Up button (▲), (C should appear on the display)
3. While continuing to hold the Up button (▲) , press the Escape (◄) button until the display flashes once.

MAINTENANCE

The Model T9000 Pressure Controllers use a supply filter to prevent detrimental particles from entering the pilot section of the unit. Clean or replace the supply filter as necessary to ensure maximum performance. For additional maintenance and troubleshooting information, see Tables 8 and 9.

Table 8. Troubleshooting

Problem	Solution
No Output	• Check the supply filter. • Check the supply pressure. • Check the inlet screen in the booster. • Check the power supply. • Check for an existing Input Signal.
Leakage	• Check for loose fittings. • Check for loose body screws.
Improper Output	• Check for output pressure leakage. • Check calibration.
Erratic Operation	• Check for liquid in the air supply. • Check for loose wires or connections. • Check for improper tuning • Check proper settings for L1 and L2
Constant Maximum Output	• The external pressure is not applied to "P" port. ("P" option only).

Table 9. LED Status

LED Status	Module Status (MS)
Off	No power - The device does not have power.
Green	Device operational - The device is operating in a normal condition.
Red	Unrecoverable fault - A RAM or ROM error occured. Return the unit to the factory.
LED Status	**Near Setpoint (NS)**
Off	The device does not have power or is not on line. Check the Module Status LED.
Green	The unit is near setpoint.
Red	The unit is NOT near setpoint.

1. **If troubleshooting does not correct the problem, return the transducer to the factory for repair.**
2. **Install Service Kit per Table 10.**
3. **To replace solenoid valves in the ModelT9000, order quantity (2) of solenoid valves listed in Table 11.**

Table 10 - Service Kit Options

Catalog No.	Thread Option	Elastomer Option	Service Kit Required
T9000-	All	Nitrile	**21458-0NE**
		Fluorocarbon	**21458-0JE**
T9010-	All	Nitrile	**21458-1N**
		Fluorocarbon	**21458-1J**
T9020-	NPTF	Nitrile	**21458-2NNE**
		Fluorocarbon	**21458-2NJE**
	BSPT/ BSPP	Nitrile	**21458-2UNE**
		Fluorocarbon	**21458-2UJE**
T9040-	All	N/A	**21458-4JE**

Table 11 - Solenoid Valves

Catalog No.	Elastomer	Solenoid Valve
T9000-	Nitrile	**290-IPI-010-1N**
	Fluorocarbon	**290-IPI-010-1J**
T9010-	Nitrile	**290-IPI-010-3N**
	Fluorocarbon	**290-IPI-010-3J**
T9020-	Nitrile	**290-IPI-010-3N**
	Fluorocarbon	**290-IPI-010-3J**
T9040-	Nitrile	**290-IPI-010-3N**
	Fluorocarbon	**290-IPI-010-3J**

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