

Section 5 Dedicated Timers

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HVAC Timers



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Dedicated
timers

Random Start or Anti-Short Cycle TAC1 Series Delay on Make HVAC/R Timer



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- UL Approved for Air Conditioning & Refrigeration Equipment
- Fixed or Adjustable Delays From 0.05 ... 600 s
- 24 ... 230 V AC, 50 ... 60 Hz
- Fail-safe Design Eliminates Contactor Chatter Problems
- +/-2% Repeat Accuracy

Approvals:

Accessories

B External adjust potentiometer
P/N: P1004-XX (fig A)
P1004-XX-X (fig B)

Mounting bracket
P/N: P1023-6

Female quick connect
P/N: P1015-64 (AWG 14/16)

Quick connect to screw adaptor
P/N: P1015-18

Versa-knob
P/N: P0700-7

Plug-on adjustment module
P/N: VTP(X)(X)
DIN rail P/Ns: C103PM (A)

DIN rail adaptor
P/N: P1023-20

See accessory pages for specifications.

Description

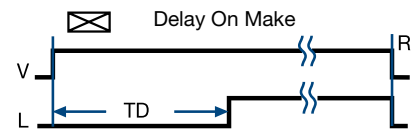
The TAC1 Series was designed to delay the operation of a compressor relay. It eliminates the possibility of relay chatter due to half-wave failure of the output. It connects in series with the load relay coil and provides a delay on make time delay each time input voltage is applied. It can be used for random start, anti-short cycling, sequencing, and many other applications. It is an excellent choice for all air conditioning and refrigeration equipment.

Operation

Upon application of input voltage, the time delay begins. The output is de-energized before and during the time delay. At the end of the time delay, the output energizes and remains energized until input voltage is removed.

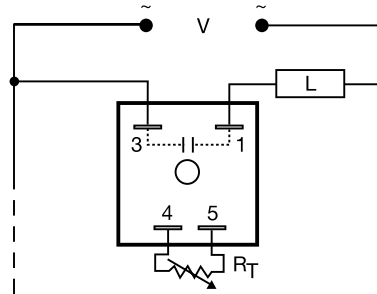
Reset: Removing input voltage resets the time delay and output.

Function



V = Voltage TD = Time Delay R = Reset
L = Load — = Undefined time

Connection



Load may be connected to terminals 3 or 1.
R_r is used when external adjustment is ordered.

Available Models-

TAC12160
TAC1411
TAC1413

TAC1217
TAC14110
TAC14164

TAC1223
TAC1412

Don't see what you need? Call us for a minimum quantity and price quote!

Ordering Table

TAC1 Series	X Input	X Adjustment	X Time Delay *
-2	24 V AC	-1 - Fixed	-1 - 0.05 ... 3 s
-4	120 V AC	-2 - External Adjust	-2 - 0.5 ... 60 s
-6	230 V AC		-3 - 2 ... 180 s
			-4 - 5 ... 600 s

Example P/N: TAC1221 Fixed - TAC141300

*If Fixed Delay is selected, insert delay [0.05 ... 600] in seconds.

Random Start or Anti-Short Cycle TAC1 Series Delay on Make HVAC/R Timer

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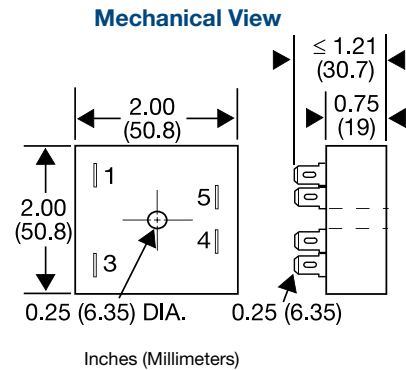
Technical Data

Time Delay	
Type	Analog circuitry
Range	0.05 ... 600 s in 4 adjustable ranges or fixed
Repeat Accuracy	+/-2%
Tolerance (Factory Calibration)	+/-20%
Recycle Time	≤ 20 ms after timing, during timing--0.1% of time delay or 75 ms, whichever is greater
Time Delay vs. Temperature & Voltage	≤ +/-10%
Input	
Voltage	24, 120, or 230 V AC
Tolerance	+/-20%
Line Frequency	50 ... 60 Hz
Output	
Type	Solid state
Form	Normally Open, open during timing
Rating	0.5 A steady state, 10 A inrush at 60°C
Voltage Drop	120 & 230 V AC: ≅ 4.2 V at 0.5 A 24 V AC: ≅ 2.5 V at 0.5 A
Protection	
Circuitry	Encapsulated
Dielectric Breakdown	≥ 2000 V RMS terminals to mounting surface
Insulation Resistance	≥ 100 MΩ
Mechanical	
Mounting	Surface mount with one #10 (M5 x 0.8) screw
Package	2 x 2 x 1.21 in. (50.8 x 50.8 x 30.7 mm)
Termination	0.25 in. (6.35 mm) male quick connect terminals
Environmental	
Operating Temperature	-40°C ... +80°C
Storage Temperature	-40°C ... +85°C
Humidity	95% relative, non-condensing
Weight	≅ 2.4 oz (68 g)

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Desired Time Delay*				R _T Megohm
Seconds				
1	2	3	4	
0.05	0.5	2	5	0.0
0.5	10	30	60	0.5
1.0	20	60	120	1.0
1.5	30	90	180	1.5
2.0	40	120	240	2.0
2.5	50	150	300	2.5
3.0	60	180	360	3.0
			420	3.5
			480	4.0
			540	4.5
			600	5.0

* When selecting an external R_T add at least 30% for tolerance of unit and the R_T.



Time Delay	VTP P/N	Fig. A P/N	Fig. B P/N
1 - 0.05 ... 3 s	VTP4B	P1004-12	P1004-12-X
2 - 0.5 ... 60 s	VTP4F	P1004-12	P1004-12-X
3 - 2 ... 180 s	VTP4J	P1004-12	P1004-12-X
4 - 5 ... 600 s	VTP5N	P1004-13	P1004-13-X

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Lockout With Random Start T2D Series HVAC/R Timer



Patent 5809793



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- Lockout Delay--Prevents Rapid Recycling of Compressor
- Random Start Delay--Helps Prevent Low Voltage Starting
- Delay on Make Timer--Optional Two Terminal Series Connection
- Totally Solid State 1 A Output
- 24 V AC ... 230 V AC in 2 Ranges

Approvals:

Accessories



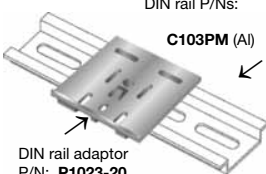
Female quick connect
P/N:
P1015-64 (AWG 14/16)



Quick connect to
screw adaptor
P/N: **P1015-18**



Mounting bracket
P/N: **P1023-6**



DIN rail P/Ns:

C103PM (Al)

DIN rail adaptor
P/N: **P1023-20**

See accessory pages for specifications.

Description

The T2D Series provides protection against short cycling of compressors and other motors. At the end of each operation, a lockout delay prevents restarting the compressor or motor until the delay is completed. 24 V AC models can be used with thermostats that include a cooling anticipator resistor. Can be connected in series with the load for delay on make operation.

Operation

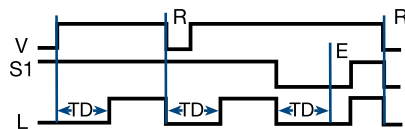
Connection #1: Upon application of input voltage, a random start time delay begins. At the end of this time delay, the output is energized. **Lockout Delay:** Input voltage must be applied prior to and during timing. When the thermostat or initiate switch opens, the output de-energizes and the lockout time delay begins. At the end of the lockout delay, the output is energized allowing the load to immediately energize when the initiate switch or thermostat closes.

Connection #2: Upon application of input voltage and closure of initiate switch, the time delay begins. At the end of the time delay, the output is energized and remains energized until power is removed.

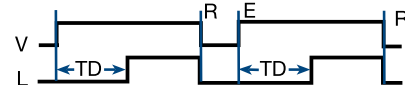
Reset: Removing power resets the output and the time delay.

Function

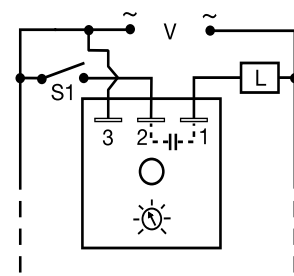
Connection Diagram #1



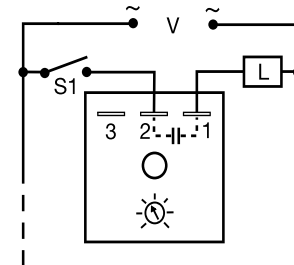
Connection Diagram #2



Connection



1
Random
Start Plus
Lockout



2
Delay On
Make

Dashed lines are internal connections.

V = Voltage L = Load
S1 = Initiate Switch or Thermostat
E = Ready R = Reset
TD = Time Delay

Available Models-

T2D120A130S

T2D120A15M

T2D120A190S

Don't see what you need? Call us for a minimum quantity and price quote!

Ordering Table

T2D
Series

X
Input
- **24A** - 24 V AC
- **120A** - 120/230 V AC

X
Adjustment
- **1** - Fixed
- **2** - Knob
Adjustable

X
Time Delay *
- **1** - 1 ... 100 s
- **2** - 10 ... 1000 s
- **3** - 0.1 ... 10 m
- **4** - 1 ... 100 m

Example P/N: T2D24A23 Fixed – **T2D120A1180S**

*If Fixed Delay is selected, insert delay [1 ... 1000] followed by (S) sec. or [0.1 ... 100] (M) min.

Lockout With Random Start

T2D Series

HVAC/R Timer

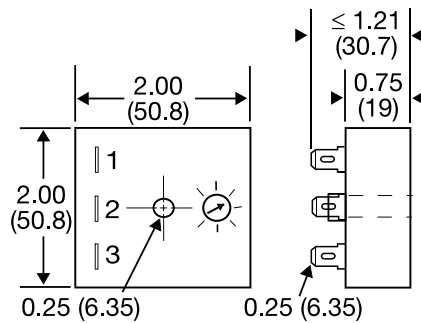
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Technical Data

Input	
Voltage	24 V AC, or 120/230 V AC in 2 ranges
Tolerance	+/-20%
Frequency	50 ... 60 Hz
Output	
Minimum Load Current	24 V AC--100 mA; 120/230 V AC--40 mA
Rating	1 A steady state, 10 A inrush at 60°C
Voltage Drop	≅ 2.5 V at 1 A
Time Delay	
Initiate Time	After timing--16 ms
Type	Analog circuitry
Lockout & Random Start Delays	1 s ... 100 m in 4 adjustable ranges or fixed Note: The lockout & random start delays are the same length.
Tolerance	Adjustable: +/-30%; Factory Fixed: +/-30%
Repeat Accuracy	+/-1% or 20 ms, whichever is greater
Reset Time	After timing--≤ 16 ms; During timing--≤ 200 ms
Protection	
Dielectric Breakdown	≥ 2000 V RMS terminals to mounting surface
Insulation Resistance	≥ 100 MΩ
Mechanical	
Mounting	Surface mount with one #10 (M5 x 0.8) screw
Package	2 x 2 x 1.21 in. (50.8 x 50.8 x 30.7 mm)
Termination	0.25 in. (6.35 mm) male quick connect terminals
Environmental	
Operating Temperature	-20°C ... +60°C
Storage Temperature	-40°C ... +85°C
Humidity	95% relative, non-condensing
Weight	≅ 2.4 oz (68 g)
Cooling Anticipator (24 V AC Units Only)	
Minimum Cooling Anticipator	≥ 3,000 Ω

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Mechanical View



Inches (Millimeters)

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Bypass Timer

TAC4 Series (Interval)

HVAC/R Timer



5

- UL Approved for Air Conditioning & Refrigeration Equipment
- Delays from 0.05 ... 300 s
- 24, 120, or 230 V AC
- Redundant Circuitry Eliminates Chatter Problems

Approvals:

Accessories

B External adjust potentiometer
P/Ns:
P1004-12 (fig A)
P1004-12-X (fig B)

Female quick connect
P/N:
P1015-64 (AWG 14/16)

Quick connect to screw adaptor
P/N: P1015-18

Versa-knob
P/N: P0700-7

Mounting bracket
P/N: P1023-6

Plug-on adjustment module
P/N:
VTP(X)(X)

DIN rail P/Ns:
C103PM (AI)

DIN rail adaptor
P/N: P1023-20
See accessory pages for specifications.

Description

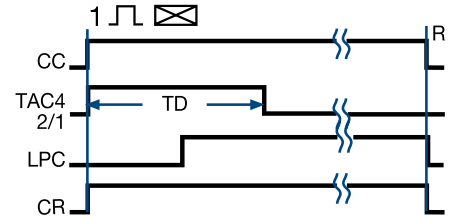
The TAC4 is a bypass timer that provides a closure across the low pressure switch during compressor startup. Its time delay circuit is totally solid state including the normally closed output. The molded housing with encapsulation, the single hole mounting, and 0.25 in. (6.35 mm) termination makes the TAC4 easy to use, rugged, and reliable.

Operation

(As shown in the connection & function diagrams) Upon application of input voltage and closure of controller contact, CC, the load, CR, energizes and the time delay begins. During the time delay, the TAC4's solid state output bypasses the LPC, low pressure switch. This allows the compressor controlled by CR to start and establish acceptable pressure. At the end of the time delay, TAC4's output de-energizes and remains de-energized until reset. The TAC4 may be used in other applications where a controlling contact must be bypassed for a specified period of time.

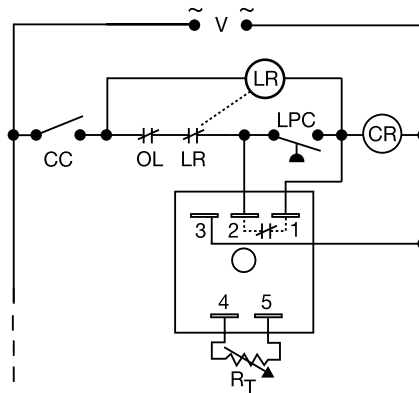
Reset: Removing input voltage or opening CC resets the output and time delay.

Function



CC = Controller Contact CR = Compressor Relay
LPC = Low Pressure Cutout
— = Undefined time

Connection



R_T is used when external adjustment is ordered.

V = Voltage LR = Lockout Relay
OL = Overload or High Pressure Switch
LPC = Low Pressure Cutout
CR = Compressor Control Relay
CC = Controller Contact

Available Models-

TAC42110

TAC4415

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Ordering Table

TAC4 Series	X Input	X Adjustment	X Time Delay*
	-2 - 24 V AC	-1 - Fixed	-1 - 0.05 ... 3 s
	-4 - 120 V AC	-2 - External Adjust	-2 - 0.5 ... 60 s
	-6 - 230 V AC		-3 - 2 ... 180 s
			-4 - 5 ... 300 s

Example P/N: TAC4221 Fixed - TAC441300

*If Fixed Delay is selected, insert delay [0.05 ... 300] in seconds.

Bypass Timer

TAC4 Series (Interval)

HVAC/R Timer

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timers

Technical Data

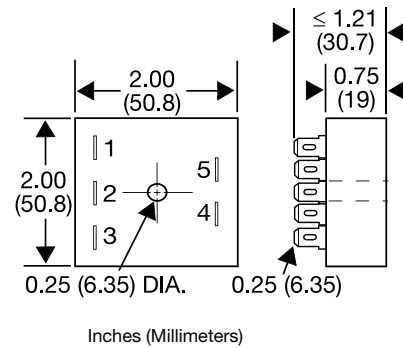
Time Delay Type Range Repeat Accuracy Tolerance (Factory Calibration) Time Delay vs. Temperature & Voltage Reset Time	Analog circuitry 0.05 ... 300 s in 4 adjustable ranges or fixed +/-2% +/-20% ≤ +/-10% ≤ 150 ms
Input Voltage Tolerance Line Frequency	24, 120, or 230 V AC +/-20% 50 ... 60 Hz
Output Type Form Rating Voltage Drop	Solid state Normally Closed, closed during timing 0.5 A steady state, 10 A inrush at 60°C 120 & 230 V AC ≅ 4.2 V at 0.5 A 24 V AC ≅ 2.5 V at 0.5 A
Protection Circuitry Dielectric Breakdown Insulation Resistance	Encapsulated ≥ 2000 V RMS terminals to mounting surface ≥ 100 MΩ
Mechanical Mounting Termination Package	Surface mount with one #10 (M5 x 0.8) screw 0.25 in. (6.35 mm) male quick connect terminals 2 x 2 x 1.21 in. (50.8 x 50.8 x 30.7 mm)
Environmental Operating Temperature Storage Temperature Humidity Weight	-40°C ... +75°C -40°C ... +85°C 95% relative, non-condensing ≅ 2.4 oz (68 g)

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Desired Time Delay*				R _T Megohm
Seconds				
1	2	3	4	
0.05	0.5	2	5	0.0
0.5	10	30	30	0.5
1.0	20	60	60	1.0
1.5	30	90	90	1.5
2.0	40	120	120	2.0
2.5	50	150	150	2.5
3.0	60	180	180	3.0
			210	3.5
			240	4.0
			270	4.5
			300	5.0

* When selecting an external R_T add at least 30% for tolerance of unit and the R_T.

Mechanical View



Time Delay	VTP P/N	Fig. A P/N	Fig. B P/N
1 - 0.05 ... 3 s	VTP4B	P1004-12	P1004-12-X
2 - 0.5 ... 60 s	VTP4F	P1004-12	P1004-12-X
3 - 2 ... 180 s	VTP4J	P1004-12	P1004-12-X
4 - 5 ... 300 s	VTP5T	P1004-13	P1004-13-X

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Lockout Timer TA Series HVAC/R Timer



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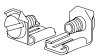
- Lockout Delay--Prevents Rapid Recycling of a Compressor
- Low Voltage Brownout Protection
- Circuitry to Activate the Cooling Anticipator (24 V AC Models)
- Eliminates Nuisance Service Calls Due to Blown Fuse or Tripped Breakers

Approvals: (24 V AC only)

Accessories



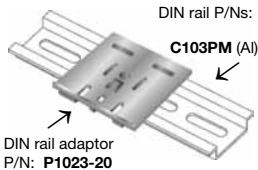
Female quick connect
P/N: **P1015-64** (AWG 14/16)



Quick connect to screw adaptor
P/N: **P1015-18**



Mounting bracket
P/N: **P1023-6**



DIN rail adaptor
P/N: **P1023-20**

See accessory pages for specifications.

Description

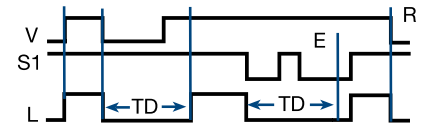
The TA Series prevents rapid recycling of a compressor. A lockout delay is started when the thermostat opens, or input voltage is lost. Eliminates tripped circuit breakers or blown fuses caused by a locked rotor during short cycling. The TA will not allow the compressor to start when the line voltage is low. Chatter of the compressor relay is eliminated. Because of the fast initiate time, bounce of the thermostat will not be transmitted to the compressor relay coil. A 30 second delay provides anti-reversing protection for scroll compressors.

Operation

On initial closure of the S1, the compressor relay energizes immediately. When S1 opens or input voltage is interrupted, a lockout time delay is initiated. During this lockout time delay, the compressor relay cannot be energized. The low voltage (*brownout*) protection prevents energization of the compressor when the line voltage is low.

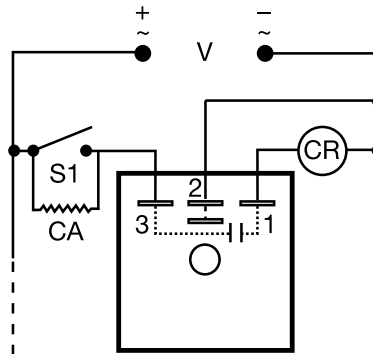
Reset: The lockout time delay cannot be reset.

Function



V = Voltage S1 = Initiate Switch or Thermostat
L = Load (CR) E = Ready R = Reset
TD = Time Delay

Connection



Dashed lines are internal connections.

S1 = Initiate Switch, Contact, or Thermostat
CR = Compressor Relay (Load) CA = Optional Cooling Anticipator

Available Models-

TA12D2
•TA24A3

TA24A0.5
•TA24A5

TA24A2

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Ordering Table

Input	Time Delay	Part Number
24 V AC	30 s	TA24A0.5
24 V AC	2 m	TA24A2
24 V AC	3 m	TA24A3
24 V AC	5 m	TA24A5
12 V DC	1 m	TA12D1
24 V DC	30 s	TA24D0.5
24 V DC	2 m	TA24D2
24 V DC	3 m	TA24D3
24 V DC	5 m	TA24D5

Lockout Timer

TA Series

HVAC/R Timer

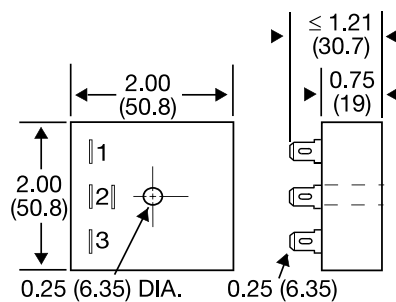
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Technical Data

Input Voltage/Frequency Impedance	12 or 24 V DC; 24 V AC, 50 ... 60 Hz 450 Ω (anticipator by-pass)
Output Minimum Load Current Maximum Load Current Voltage Drop	75 mA 1 A at 60°C ≤ 1.25 V
Time Delay Initiate Time Lockout Time Tolerance	$\cong 16$ ms Fixed 0.5, 1, 2, 3, or 5 m -15% ... +35%
Protection Circuitry Low Voltage Protection Dielectric Breakdown Insulation Resistance	Encapsulated $\cong 20$ V: 24 V AC/DC; $\cong 9$ V: 12 V DC ≥ 2000 V RMS terminals to mounting surface ≥ 100 M Ω
Mechanical Mounting Package Termination	Surface mount with one #10 (M5 x 0.8) screw 2 x 2 x 1.21 in. (50.8 x 50.8 x 30.7 mm) 0.25 in. (6.35 mm) male quick connect terminals
Environmental Operating Temperature Storage Temperature Humidity Weight	-40°C ... +70°C -40°C ... +85°C 95% relative, non-condensing $\cong 2.4$ oz (68 g)
Thermostat Cooling Anticipator Resistor	≥ 1800 Ω

5

Mechanical View



Inches (Millimeters)

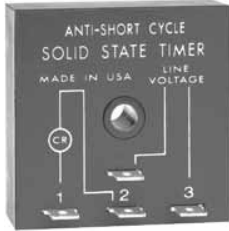
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Lockout Timer

TL Series

HVAC/R Timer

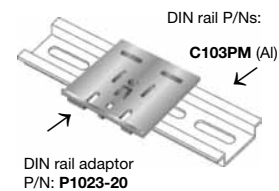
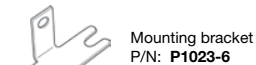
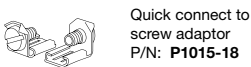
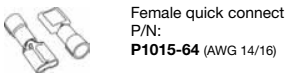


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- Lockout Delay--Prevents Short Cycling of a Compressor
- Optional 1 s Delay On Make Prevents Contactor Chatter
- Totally Solid State and Encapsulated
- 24 V AC ... 230 V AC in 3 Ranges
- Eliminates Nuisance Service Calls Due to Blown Fuse or Tripped Breakers

Approvals:

Accessories



See accessory pages for specifications.

Description

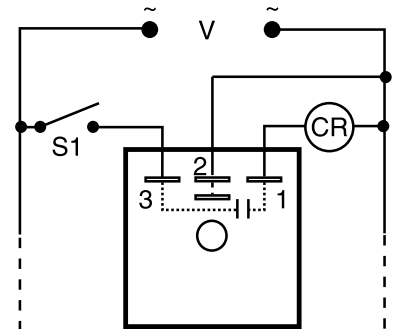
The TL Series provides protection against short cycling of a compressor. At the end of each operation, or whenever power is lost, a lockout delay is initiated. This lockout delay prevents restarting of the compressor until the head pressure has equalized. Compressor relay chatter due to thermostat bounce is eliminated by use of optional one second delay on make. The TL Series should not be used with cooling anticipator resistors or solid state switches. (See the TA Series).

Operation

Lockout: On initial closure of S1, the compressor relay energizes immediately (or after an optional 1 s delay). When the S1 opens or input voltage is interrupted, the output opens and remains open for the lockout time delay. During this lockout time delay period, the compressor relay cannot be re-energized.

Reset: The lockout time delay cannot be reset. After the time delay is completed, the unit automatically resets.

Connection



V = Voltage S1 = Initiate Switch
CR = Compressor or Control Relay

Available Models-

• TL120A5
TL230A5
TL24A5

• TL120A5T
TL230A5T
TL24A5T

TL230A2
TL24A3T

Don't see what you need? Call us for a minimum quantity and price quote!

Ordering Table

TL Series	X Input	X Lockout Time	X Delay On Make
	24 A - 24 V AC	2 m	(Blank) No delay
	120 A - 120 V AC	3 m	T - 1 s
	230 A - 230 V AC	5 m	

Example P/N: **TL24A2T, TL120A5**

Lockout Timer

TL Series

HVAC/R Timer

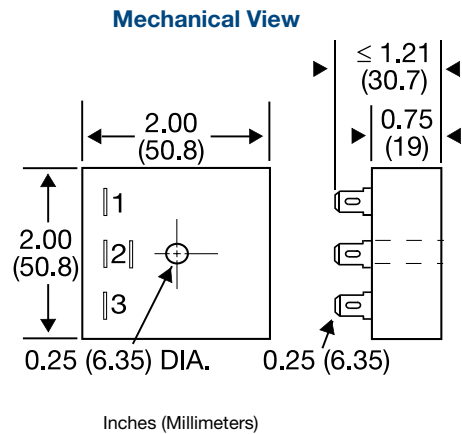
Dedicated
timers

Technical Data

Input Voltage Tolerance	24, 120, or 230 V AC, 50 ... 60 Hz +/-20%
Output Minimum Load Current Maximum Load Current Inrush Current Voltage Drop	≤ 40 mA 1 A at 24 V AC; 0.5 A at 120 & 230 V AC at 60°C 10 A at 60°C 24 V AC-- 2.5 V at 1 A 120 & 230 V AC -- 4.2 V at 0.5 A
Time Delay Initiate Time Lockout Time* Tolerance Option	≅ 8 ms Fixed 2, 3, or 5 m -15% ... +35% 1 s Delay on make eliminates contactor chatter due to thermostat bounce
Protection Circuitry Dielectric Breakdown Insulation Resistance	Encapsulated ≥ 2000 V RMS terminals to mounting surface ≥ 100 MΩ
Mechanical Mounting Package Termination	Surface mount with one #10 (M5 x 0.8) screw 2 x 2 x 1.21 in. (50.8 x 50.8 x 30.7 mm) 0.25 in. (6.35 mm) male quick connect terminals
Environmental Operating Temperature Storage Temperature Humidity Weight	-40°C ... +70°C -40°C ... +85°C 95% relative, non-condensing ≅ 2.4 oz (68 g)

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*Power must be applied for at least 15 s to achieve a full lockout delay.
 Less than 15 s will result in proportionally shorter delay periods.
 NOTE: Cooling anticipator resistor or leakage may cause erratic operation.
 See TA Series for use with 24 V AC systems that include anticipator resistors or use solid state switches.



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Delay On Make/Break CT Series HVAC/R Timer



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- Delay on Make and Delay on Break in One Unit
- Use For Fan Delays in Heating or Cooling Equipment
- Use For Multiple Load Sequencing
- 24 V AC Operation
- Factory Fixed Delays From 1 ... 600 s in 1 s Increments

Approvals:

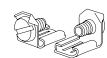
Accessories



Mounting bracket
P/N: P1023-6

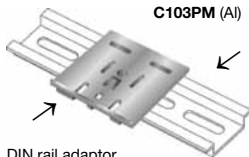


Female quick connect
P/N: P1015-64 (AWG 14/16)



Quick connect to screw adaptor
P/N: P1015-18

DIN rail P/Ns:
C103PM (Al)



DIN rail adaptor
P/N: P1023-20

See accessory pages for specifications.

Description

The CT Series combines a delay on make and delay on break time delay into one unit and may be used to control fan delays in heating and/or cooling equipment. The CT includes bypass circuitry to allow it to operate with cooling anticipators ≥ 3000 ohms. It is designed to operate in 24 V AC control circuits. Several CT modules may be combined to provide sequencing ON of any number of loads and sequencing OFF of the same loads, such as electric heating elements.

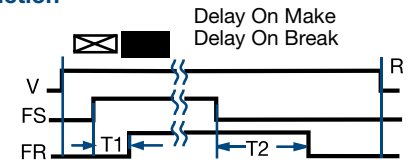
Operation

Forced Air Heating or Air Conditioning (as shown):

When the thermostat closes, the compressor relay is immediately energized. At the end of a fixed delay on make delay (T1), the fan relay is energized. When the thermostat opens, the compressor relay is de-energized and the delay on break delay is initiated. On completion of the fixed delay on break delay (T2) the fan relay is de-energized. If the thermostat is reclosed during the delay on break delay, the delay on break delay is reset and the fan relay remains energized. If the thermostat is closed when input voltage is applied, the delay on make delay (T1) begins as normal.

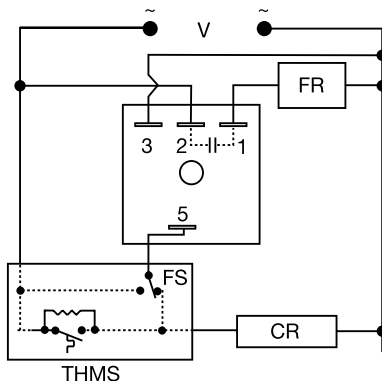
Reset: Removing input voltage resets the output and time delays.

Function



V = Voltage R = Reset
FS = Fan Switch FR = Fan Relay
T1 = Delay On Make T2 = Delay On Break
— = Undefined time

Connection



CR = Compressor Relay THMS = Wall Thermostat
Dashed lines are internal connections.

Available Models-

CT1S12	CT1S30	CT1S300
•CT1S45	CT1S8	CT1S90
CT30S1	CT30S150	•CT45S45

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Ordering Table

<u>CT</u> Series	<u>X</u> Delay on Make (Fixed) Specify time in seconds from 1 ... 600 s followed by (S)	<u>X</u> Delay on Break (Fixed) Specify time in seconds from 1 ... 600 s
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Example P/N: **CT1S120, CT20S60**

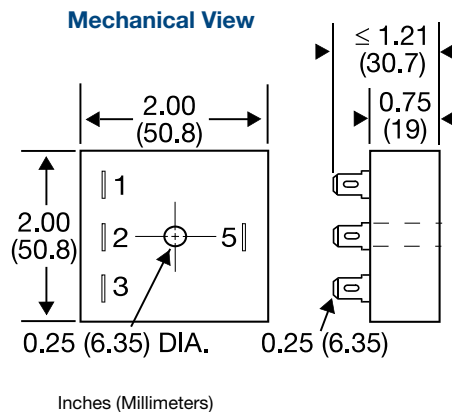
Delay On Make/Break CT Series HVAC/R Timer

Dedicated
timers

Technical Data

Time Delay	
Type	Microcontroller
Range	1 ... 600 s
Repeat Accuracy	+/-5%
Tolerance (Factory Calibration)	+/-20%
Recycle Time	≤ 300 ms
Input	
Voltage	24 V AC
Tolerance	+/-15%
Line Frequency	50 or 60 Hz
Output	
Type	Solid state
Form	Normally open
Rating	0.75 A steady state, 5 A inrush at 55°C
Voltage Drop	≅ 1.25 V
Protection	
Circuitry	Encapsulated
Dielectric Breakdown	≥ 2000 V RMS terminals to mounting surface
Insulation Resistance	≥ 100 MΩ
Mechanical	
Mounting	Surface mount with one #10 (M5 x 0.8) screw
Package	2 x 2 x 1.21 in. (50.8 x 50.8 x 30.7 mm)
Termination	0.25 in. (6.35 mm) male quick connect terminals
Environmental	
Operating Temperature	-40°C ... +70°C
Storage Temperature	-40°C ... +85°C
Humidity	95% relative, non-condensing
Weight	≅ 2.4 oz (68 g)
Thermostat	Anticipator Resistor: ≥ 3000 Ω

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