FOXBORO®

Instruction

MI 018-575
February 1997

I/A Series®
Model 716C 1/16 DIN Temperature Controller

Installation, Configuration, and Operation

SIEBE®

A Siebe Group Company

Contents

1. Introduction

Overview

The Foxboro Model 716C 1/16 DIN Temperature Controller establishes a new class of microprocessor-based temperature controllers with expanded system safety and data collection capabilities. Designed specifically for manufacturers who need communication with data acquisition equipment, the 716C offers a variety of standard features commonly found in the industry only as extra cost options. NEMA 4X faceplates permit these units to be used in applications where washdowns and dust conditions exist.

Easy to configure, light, and very compact, the 716C can perform reliably in the most demanding applications.

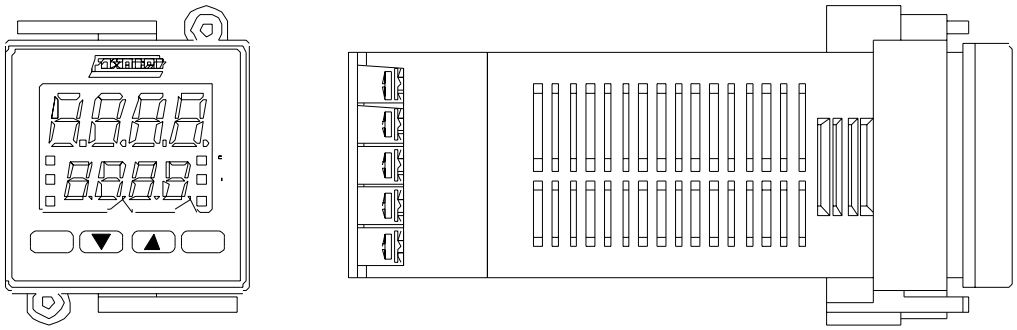


Figure 1. 716C Outline Drawing

Reference Documents

Refer to the following documents for additional information on the 716C Controller.

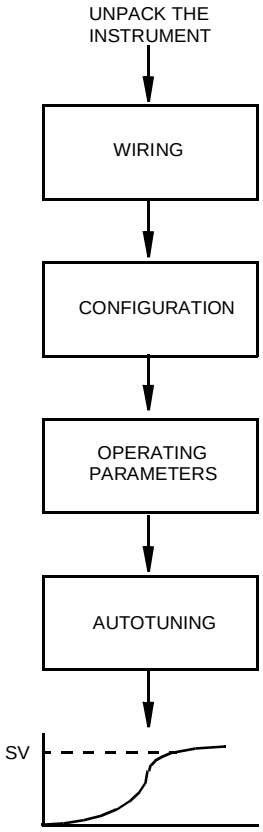
Document	Description
DP 018-575	Dimensional Print for Model 716C 1/16 DIN Controller
PSS 2C-1B5 A	Product Specifications for Model 716C 1/16 DIN Controller
MI 018-579	Serial Communication Guide for 716C 1/16 DIN Temp. Controller and the 718TC Temperature Controller

Quick Start

Only four steps are required to set up a 716C controller:

1. Wire the instrument (page 3).
2. Configure the instrument (page 9).
3. Check the operating mode parameters (page 23).

4. Check the autotune (Smart AT) process (page 16)



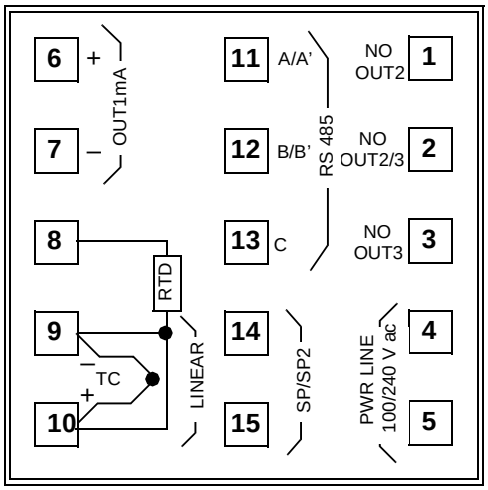
***CAUTION**: Use wire suitable for 75°C minimum.*

NOTE:
For supply connections, use No. 16 AWG or larger wires rated for at least 75°C. Use copper conductors only. Class 2 wiring must be separated a minimum of 1/4 inch from any Class 1 conductors.

2. Installation

Wiring Guidelines

Terminal Board



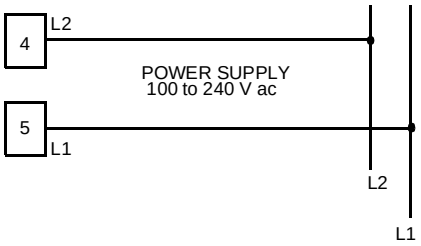
NOTE

WHEN A RELAY OUTPUT IS USED TO DRIVE AN INDUCTIVE LOAD, CONNECT AN EXTERNAL SNUBBER NETWORK (RC) ACROSS THE TERMINALS IN ACCORDANCE WITH THE FOLLOWING TABLE:.

Load (mA)	C (μF)	R (Ω)	P (W)	Operating Voltage
<40 mA	0.047	100	1/2	260 V ac
<150 mA	0.1	22	2	260 V ac
<0.5 Amp	0.33	47	2	260 V ac

NOTE: NO GROUND CONNECTION IS REQUIRED.

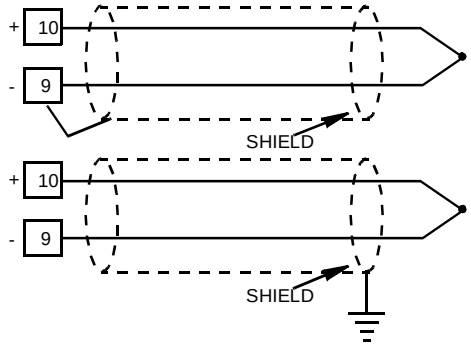
Power Line and Grounding



NOTES

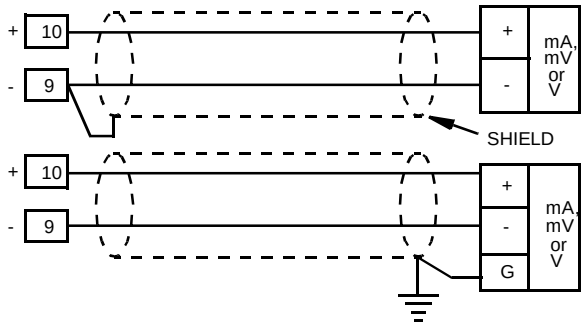
1. WHEN THE NEUTRAL LINE IS PRESENT, CONNECT IT TO TERMINAL 4.
2. BEFORE CONNECTING THE POWER LINE, VERIFY THAT THE VOLTAGE IS CORRECT (SEE MODEL NUMBER).
3. TO AVOID ELECTRIC SHOCK AND POSSIBLE INSTRUMENT DAMAGE, CONNECT POWER LAST.

Measuring Inputs



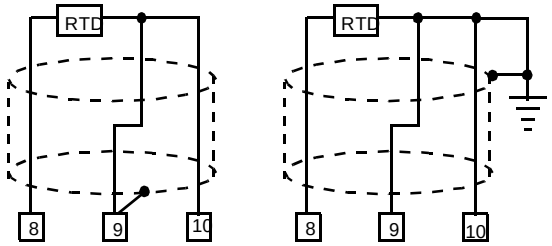
NOTE

DO NOT RUN INPUT WIRES WITH POWER CABLES. FOR TC WIRING, USE PROPER COMPENSATING CABLE, PREFERABLY SHIELDED (SEE TABLE 1 ON PAGE 4). SHIELDED CABLE SHOULD BE GROUNDED AT ONE END ONLY.



NOTE

TO AVOID GROUND LOOP CURRENTS, SHIELDED CABLE SHOULD BE GROUNDED AT ONE END ONLY.



NOTES

1. DO NOT RUN RTD WIRES WITH POWER CABLES. SHIELDED CABLE SHOULD BE GROUNDED AT ONE END ONLY. USE THE CORRECT SIZE COPPER WIRES. THE RESISTANCES OF THE THREE WIRES MUST BE THE SAME.
2. ANY EXTERNAL COMPONENTS (LIKE ZENER DIODES, ETC.) CONNECTED BETWEEN THE SENSOR AND INPUT TERMINALS CAN CAUSE MEASUREMENT ERRORS (EXCESSIVE OR UNBALANCED LINE RESISTANCE OR POSSIBLE LEAKAGE CURRENTS).

Table 1. Thermocouple Compensating Cable Color Codes

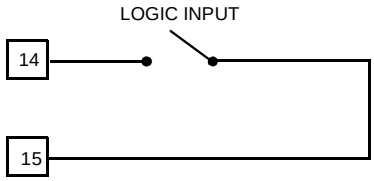
Thermocouple Material		British BS 1843	American ANSI MC 96.1	German DIN 43710	French NFE 18-001
T	Copper Constantan	+White -Blue Blue	+ Blue - Red Blue	+ Red - Brown Brown	+ Yellow - Blue Blue
J/L	Iron Constantan	+ Yellow - Blue Black	+ White - Red Black	+ Red -Blue Blue	+ Yellow - Black Black
K	Nickel Chromium Nickel Aluminum	+ Brown - Blue Red	+ Yellow - Red Yellow	+ Red - Green Green	+ Yellow - Purple Yellow
R	Platinum/Platinum 13% Rhodium	+White - Blue Green	+Black - Red Green	+ Red - White White	+White - Green Green
S	Platinum/Platinum 10% Rhodium	+White - Blue Green	+Black - Red Green	+ Red - White White	+White - Green Green
E	Chromel Constantan	+ Brown - Blue Brown	+ Violet - Red Violet	- - -	- - -

Table 1. Thermocouple Compensating Cable Color Codes (Continued)

Thermocouple Material		British BS 1843	American ANSI MC 96.1	German DIN 43710	French NFE 18-001
B	Platinum 30% Rh Platinum 6% Rh	- - -	+ Gray - Red Gray	- - -	- - -
N	Nicrosil/Nisil	-	-	-	-

Logic Inputs

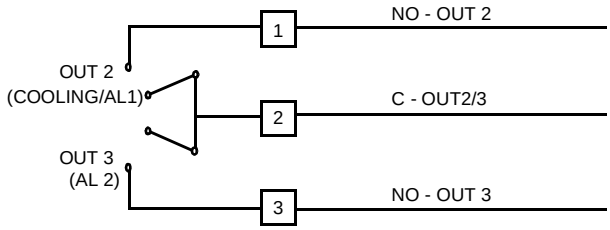
This input selects between SP and SP2 as the operating set point.



SAFETY NOTES

DO NOT RUN LOGIC INPUT WIRING WITH ac POWER CABLES.
USE AN EXTERNAL CONTACT WITH A CONTACT RATING GREATER THAN 0.5 mA, 5 V dc.
THE INSTRUMENT NEEDS 100 MS TO RECOGNIZE A CONTACT STATUS CHANGE.

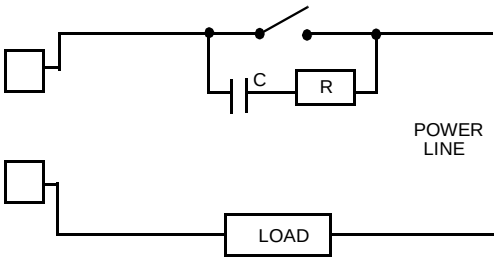
Relay Outputs



RELAY OUTPUT: PROTECTED BY VARISTOR.
OUT 2: CONTACT RATING OF 2 A/250 V ac RESISTIVE LOAD.
OUT 3: CONTACT RATING OF 2 A/250 V ac RESISTIVE LOAD.
NUMBER OF OPERATIONS: 2 X 10^5 AT THE SPECIFIED RATED CONDITIONS.

Inductive Loads

High voltage transients may occur when switching inductive loads. It is recommended to install an additional RC network across the external contacts as shown below.



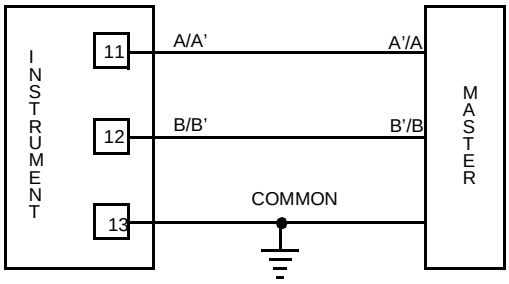
THE VALUE OF CAPACITOR (C) AND RESISTOR (R) ARE SHOWN IN THE FOLL(ING TABLE.

Load Current	C (μF)	R (Ω)	Power (Watts)	Resistor/ Capacitor Voltage
Less than 40 mA	0.047	100	1/2	260
Less than 150 mA	0.1	22	2	260
Less than 0.5 A	0.33	47	2	260

THE CABLE USED FOR RELAY OUTPUT WIRING MUST BE AS FAR AWAY AS P(SIBLE FROM INPUT OR COMMUNICATION CABLES.

Serial Interface

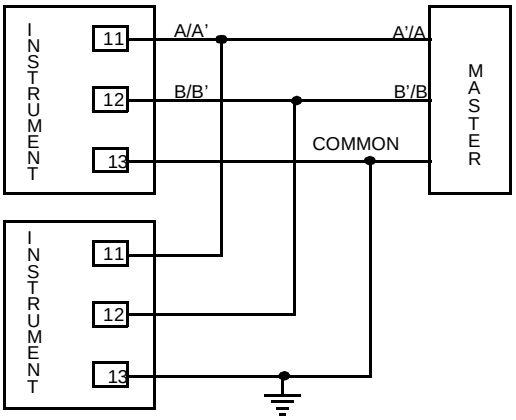
The RS-485 interface can connect up to 31 instruments with the remote master unit (see below).



NOTES

MAXIMUM CABLE LENGTH: 1.5 KM (9/10 MILE) AT 9600 BAUD.

NOTES: ACCORDING TO EIA SPECIFICATIONS FOR RS-485.
1. THE "A" TERMINAL OF THE GENERATOR SHALL BE NEGATIVE WITH RESPECT TO THE "B" TERMINAL FOR A BINARY 1 (MARK OR OFF) STATE.
2. THE "A" TERMINAL OF THE GENERATOR SHALL BE POSITIVE WITH RESPECT TO THE "B" TERMINAL FOR A BINARY 0 (SPACE OR ON) STATE.

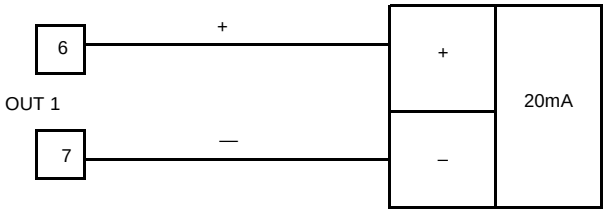


CONNECT THE INSTRUMENT (MAXIMUM OF 31) TO THE MASTER UNIT BY RS-485 COMMUNICATION.

Linear Output

This instrument is equipped with one linear output (OUT 1) programmable as:

- Main output (heating or cooling).
- Secondary output (cooling).
- Analog retransmission of the measured value.
- Analog retransmission of the operating set point.

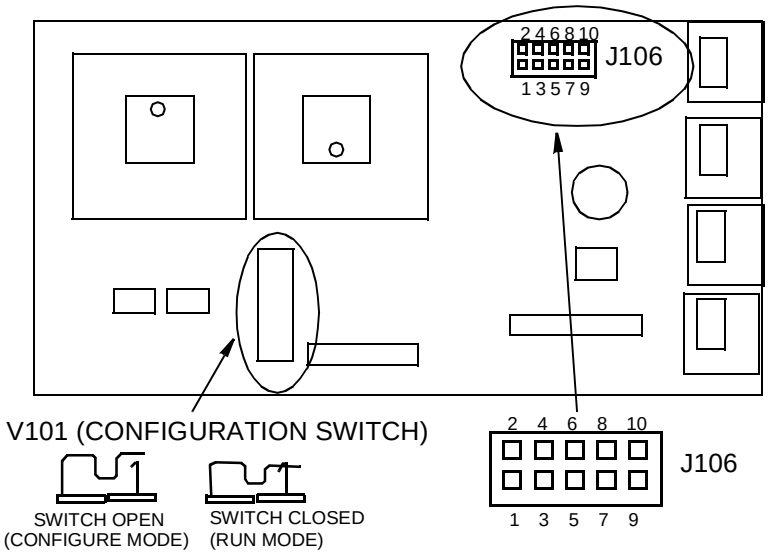


THIS IS AN ISOLATED ANALOG OUTPUT WITH A MAXIMUM LOAD OF 500 Ω.

Preliminary Switch Settings

1. Remove the instrument from its housing. (Insert flat-blade screwdriver into slot at right side of bezel and pull instrument forward from housing.)
2. Set J106 according to the following table.

	J106				
Input Type	**1-2**	**3-4**	**5-6**	**7-8**	**9-10**
TC-RTD	open	close	open	open	open
60 mV	open	close	open	open	open
5 V	close	open	close	open	open
10 V	open	open	close	open	open
20 mA	open	open	open	close	close



Open Input Circuit

This instrument is able to identify the open circuit for TC and RTD inputs. The open input circuit condition for RTD and T/C inputs is shown by an “overrange” indication:

Overrange (STD)	CH101 = close	SH101 = open

3. Configuration

Configuration Key Functions

FUNC = The new setting of the selected parameter is stored and the next parameter is displayed (in increasing order).
MAN = Scrolls back through the parameters without storing the new setting.
Δ = Increases the setting of the selected parameter.
∇ = Decreases the setting of the selected parameter.

Configuration Procedure

1. Remove the instrument from its case.
2. Open configuration switch V101, located 1 inch behind the upper right corner of the display (see "Preliminary Switch Settings" on page 7).
3. Reinsert the instrument in its case.
4. Switch on power to the instrument. The display shows COnF.

NOTE: If "CAL" is displayed, press the Δ key to return to the configuration procedure.

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5. Press the FUNC key.

Configure Serial Communication

SEr1 = Serial Interface Protocol

OFF = No serial interface.
Ero = Poll/select using Foxboro proprietary protocol.
nbUS = Modbus
jbUS = Jbus

SEr2 = Serial Link Device Address

Not available when SEr1 = OFF.
From 1 to 95 for Foxboro proprietary protocol.
From 1 to 255 for all other protocols.

NOTE: The electrical characteristics of the RS-485 serial interface allow 31 devices maximum.

SEr3 = Baud Rate for Serial Link

Not available when SEr1 = OFF.
From 600 to 19200 baud.

NOTE: 19200 baud is displayed as 19.2.

SEr4 = Byte Format For Serial Link

Not available when SEr1 = OFF.

7E = 7 bits + even parity (For Foxboro proprietary protocol only)
7O = 7 bits + odd parity (For Foxboro proprietary protocol only)
8E = 8 bits + even parity
8O = 8 bits + odd parity
8 = 8 bits without parity

Configure Inputs and Range Values

P1 = Input Type and Standard Range

0	= TC type	L	range	0	to	+400.0°C
1	= TC type	L	range	0	to	+900°C
2	= TC type	J	range	0	to	+400.0°C
3	= TC type	J	range	0	to	+1000°C
4	= TC type	K	range	0	to	+400.0°C
5	= TC type	K	range	0	to	+1200°C
6	= TC type	T	range	0	to	+400.0°C
7	= TC type	N	range	0	to	+1400°C
8	= TC type	R	range	0	to	+1760°C
9	= TC type	S	range	0	to	+1760°C
10	= RTD type	Pt 100	range	-199.9	to	+400°C
11	= RTD type	Pt100	range	-200	to	+800°C
12	= mV	Linear	range	0	to	60 mV
13	= mV	Linear	range	12	to	60 mV
14	= mA	Linear	range	0	to	20 mA
15	= mA	Linear	range	4	to	20 mA
16	= V	Linear	range	0	to	5 V
17	= V	Linear	range	1	to	5 V
18	= V	Linear	range	0	to	10 V
19	= V	Linear	range	2	to	10 V
20	= TC type	L	range	0	to	+1650°F
21	= TC type	J	range	0	to	+1830°F
22	= TC type	K	range	0	to	+2190°F
23	= TC type	T	range	0	to	+750°F
24	= TC type	N	range	0	to	+2550°F
25	= TC type	R	range	0	to	+3200°F
26	= TC type	S	range	0	to	+3200°F
27	= RTD type	Pt 100	range	-199.9	to	+400.0°F
28	= RTD type	Pt 100	range	-330	to	+1470°F

NOTE: When P1 = 0, 2, 4, 9, or 25 sets the digital filter (P36) to FLtr. For all the remaining ranges it sets the filter to nOFL.

P2 = Decimal Point Position

This parameter is available only when a linear input is selected (P1 = 11, 12, 13, 14, 15, 16, 17, or 18).

_ _ _ _ .= No decimal.
_ _ _ . _ = One decimal place.
_ _ . _ _ = Two decimal places.
_ . _ _ _ = Three decimal places.

P3 = Initial Scale Value (Low)

Programmable from -1999 to 4000 for linear inputs, and within the input range for TC and RTD.

When this parameter is modified, rL also changes.

P4 = Full Scale Value (High)

Can be set with keys from -1999 to 4000 for linear inputs.
Can be set with keys within the input range for TC and RTD. When this parameter is modified, rH also changes.
The initial and full scale values determine the input span used by the PID algorithm, autotuning (Smart AT), and the alarm functions.

NOTE: Minimum input span (S = P4 - P3) is as follows:
For linear inputs, S $\geq$ 100 units.
For TC input with °C readout, S $\geq$ 300°C.
For TC input with °F readout, S $\geq$ 550°F.
For RTD input with °C readout, S $\geq$ 100°C.
For RTD input with °F readout, S $\geq$ 200°F.

Configure Outputs and Alarm Range

P5 = Output 1 Action

rEv = Used as a reverse acting control output.
dir = Used as a direct acting control output.
Pv.rt = Used as an analog retransmission of the process variable.
Sp.rt = Used as an analog retransmission of the operating set point.

NOTE: Only one of the 3 outputs, P5, P9, P11, can be configured as reverse acting and only one of these 3 outputs can be configured as direct acting. If none of these outputs is configured as a control output, the instrument operates as an indicator.

P6 = Output 1 Type

0-20 = Output type: 0 - 20 mA.
4-20 = Output type: 4 - 20 mA.

P7 = Analog Retransmission - Initial Scale Value

Available only when P5 = Pv.rt or SP.rt.
Can be set with keys from -1999 to 4000. The decimal point is positioned as selected with parameter P2.

P8 = Analog Retransmission - Full Scale Value

Available only when Pr - Pv.rt or SP.rt.Can be set with keys from -1999 to 4000. The decimal point is positioned as selected with parameter P2.

P9 = Output 2 Function

nonE = Not used.
rEv = Used as a reverse acting control output.
dir = Used as a direct acting control output.
AL1.P = Used as Alarm 1output and Alarm 1 is programmed as a process alarm.
AL1.b = Used as Alarm 1output and Alarm 1is programmed as a band alarm.
AL1.d = Used as Alarm 1output and Alarm 1is programmed as a deviation alarm.

NOTE: If P9 is set to rEv (reverse acting control output), the cycle time (CY2) is 15 seconds.

If P9 is set to dir (direct acting control output), the cycle time (CY2) is:
10 seconds when P22 is equal to "Alr" (air as cooling medium)
4 seconds when P22 is equal to "OIL" (oil as cooling medium)
2 seconds when P22 is equal to "H2O" (water as cooling medium).

P10 = Alarm 1 Operating Mode

Available only when P9 is set to "AL1.P," "AL1.b" or "AL1.d."

H.A. = High alarm (or outside of the band) with automatic reset.
L.A. = Low alarm (or inside the band) with automatic reset.
H.L. = High alarm (or outside of the band) with manual reset.
L.L. = Low alarm (or inside the band) with manual reset.

P11 = Output 3 Function

nonE = Not used.
rEv = Used as reverse acting control output.
dir = Used as direct acting control output.
AL2.P = Used as Alarm 2 output and Alarm 2 is programmed as a process alarm.
AL2.b = Used as Alarm 2 output and Alarm 2 is programmed as a band alarm.
AL2.d = Used as Alarm 2 output and Alarm 2 is programmed as a deviation alarm.

NOTES:
1.If P11 = rEv (reverse acting control output), cycle time (CY3) = 15 seconds.
2. If P11 = dir (direct acting control output), cycle time (CY3) is:
10 seconds when P22 is equal to "Alr" (air as cooling medium)
4 seconds when P22 is equal to "OIL" (oil as cooling medium)
2 seconds when P22 is equal to "H2O" (water as cooling medium)

P12 = Alarm 2 Operating Mode

Available only when P11 is set to "AL2.P," "AL2.b" or "AL2.d."
H.A. = High alarm (or outside of the band) with automatic reset.
L.A. = Low alarm (or inside the band) with automatic reset.
H.L. = High alarm (or outside of the band) with manual reset.
L.L. = Low alarm (or inside the band) with manual reset.

Configure Alarm Set Points and Soft Start

P13 = Programmability of the Alarm 2 Set Point and Hysteresis Value

Available only when P11 is set to "AL2.P," "AL2.b" or "AL2.d."
OPrt = Alarm 2 set point and hysteresis can be set with keys in the operating mode.
COnF = Alarm 2 set point and hysteresis can be set with keys in the configuration mode.

P14 = Alarm 2 Set Point

Available only when P11 is set to "AL2.P," "AL2.b" or "AL2.d" and P13 is set to "COnF."
Range: For process alarm - Within the range limits.
For band alarm - From 0 to 500 units.
For deviation alarm - From -500 to 500 units.

P15 = Alarm 2 Hysteresis Value

Available only when P11 is set to "AL2.P," "AL2.b" or "AL2.d" and P13 is set to "COnF."
Range: From 0.1% to 10.0% of the range selected with P3 and P4 parameters.

P16 = Soft Start Set Point

Set point setting (in engineering units), to initiate the "Soft start" function (output power limiting) at startup.
Range: Within the readout span.

NOTE: This set point setting is not used when tOL = InF.

Configure Safety Lock

P17 = Safety Lock

Using the ∆ and ∇ keys set P18 according to the following conditions:

0 = Unlocked. The device is always unlocked and all parameters can be modified.
1 = Locked. No parameters (except the set point and alarm manual reset) can be modified.

For autotune (Smart AT) status see "P30 = Autotune (Smart AT) Function" on page 16.

From 2 to 9999 = This code number is a password used to unlock the device (set point and alarm manual reset are always unlocked). For autotune status see "P30 = Autotune (Smart AT) Function" on page 16.

The configuration procedure is now complete. The instrument should show "-.-.-." on both displays. Press the FUNC key; the instrument returns to the beginning of the configuration procedure. To end configuration and go to operating mode:

1. Remove the instrument from its case.

2. Set switch V101 to the closed position.
3. Reinsert the instrument in its case.
4. Switch on the instrument.

Advanced Configuration Procedure

To access the advanced configuration parameters, proceed as follows:

1. Using the Δ or ∇ keys, set the code to 262.
2. Press the FUNC key.

Configure Output Actions and Displayed Values

P18 = Main Control Output Action

This parameter is skipped if no control output is configured.
norL = The power output is the result of the PID calculation.
CnPL = The power output is the complement of the PID calculation (100 - PID).

P19 = Displayed Value of the Main Power Output

This parameter is skipped if no control output is configured.
norL = The displayed value is the result of PID calculation.
CnPL = The displayed value is the complement of the PID Calculation (100 - PID).

P20 = Secondary Control Output Action

This parameter is available only when two control outputs are configured.
norL = The displayed value is the result of PID calculation.
CnPL = The displayed value is the complement of the PID Calculation (100 - PID).

P21 = Displayed Value of the Power Output for the Secondary Control Output

This parameter is available only when two control outputs are configured.
norL = The displayed value is the result of PID calculation.
CnPL = The displayed value is the complement of the PID Calculation (100 - PID).

NOTE: When two control outputs are configured, P18 and P19 are applied to the "rEv" (reverse) acting output; P20 and P21 are applied to the "dir" (direct) acting output.

P22 = Cooling Media

This parameter is available only when two control outputs are configured.
AIr = Air is used as the cooling media.
OIL = Oil is used as the cooling media.
H2O = Water is used as the cooling media.

Changing P22 forces the cycle time and relative cooling gain parameters to the default value related with the selected cooling media.

When:

P22 = AIr	- CYx = 10 seconds	and rC = 1.00
P22 = OIL	- CYx = 4 seconds	and rC = 0.80
P22 = H2O	- CYx = 2 seconds	and rC = 0.40

Where CYx is the cycle time (CY2 or CY3) of the "dir" acting control output.

P23 = Relative Cooling Gain Calculated by Autotuning (Smart AT)

This parameter is available only when two control outputs are configured.
OFF = Autotuning algorithm does not calculate rC.
ON = Autotuning algorithm calculates rC.

Configure Alarm Actions

P24 = Alarm 1 Action

Available only when P9 = "AL1.P," or "AL1.b," or "AL1.d."
dir = Direct (relay energized in alarm condition).
rEV = Reverse (relay deenergized in alarm condition).

P25 = Alarm 1 Standby

Available only when P9 = "AL1.P" or "AL1.b" or AL1.d"
OFF = Standby function disabled.
ON = Standby function enabled.

NOTE: If the alarm is a band or deviation alarm, the alarm is masked after a set point change or at startup until the process variable reaches the alarm set point plus or minus hysteresis. If the alarm is a process alarm, the condition is masked at startup until the process variable reaches the alarm set point plus or minus hysteresis.

P26 = Alarm 2 Action

Available only when P11 = "AL2.P" or "AL2.b" or "AL2.d"
dir = Direct acting (relay energized in alarm condition).
rEV = Reverse acting (relay deenergized in alarm condition).

P27 = Alarm 2 Standby

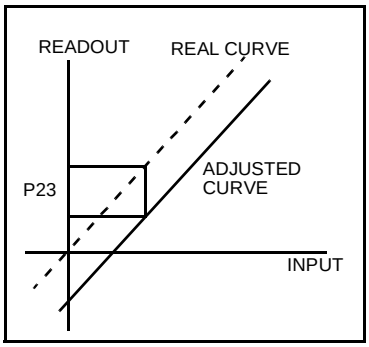
Available only when P11 = "AL2.P" or "AL2.b" or "AL2.d"
OFF = Standby disabled.
ON = Standby enabled.

Configure Offset

P28 = OFFSET Applied to the Measured Value

Used to apply a constant OFFSET throughout the range (not used for linear inputs).

- For ranges with a decimal place, P28 can be set with keys from -19.9 to 19.9.
- For ranges without a decimal place, P28 can be set with keys from -199 to 199.



Configure Display Protection

P29 = Display Protected Parameters

This parameter is skipped when P17 = 0.
OFF = Protected parameters cannot be displayed.
ON = Protected parameters can be displayed.

Configure Autotuning with Smart Function

P30 = Autotune (Smart AT) Function

This parameter is skipped if no control outputs are configured.
0 = Autotuning disabled.
1 = Autotuning is NOT protected by safety lock.
2 = Autotuning is under safety lock protection.

P31 = Maximum Value of the Proportional Band Calculated by Autotuning

This parameter is skipped if no control outputs are configured or P30 = 0.
Programmable from P32 value to 200.0%.

P32 = Minimum Value of the Proportional Band Calculated by Autotuning

This parameter is skipped if no control outputs are configured or P30 = 0.
Can be set with keys from 1.0% to P31.

P33 = Minimum Value of the Integral Time Calculated by Autotuning.

This parameter is skipped if no control outputs are configured or P30 = 0. It can be set with keys from 00.01(mm.ss) to 02.00 (mm.ss).

Configure Auto/Manual Function

P34 = MANUAL Function

This parameter is skipped if no control outputs are configured.
OFF = Manual function is disabled.
ON = Manual function can be enabled/disabled by MAN key.

P35 = Device Status at Instrument Startup

This parameter is skipped if no control outputs are configured or P34 = OFF.
0 = The instrument starts in AUTO mode.
1 = The instrument starts in MANUAL mode with the power output set to 0%.
2 = The instrument starts in the same mode it was in prior to shutdown, but if the instrument was in the manual mode, it restarts with a power output equal to 0%.
3 = The instrument starts in the same mode it was in prior to shutdown but if the instrument was in manual mode, it restarts with the same power output it had prior to shutdown.

Configure Timeout

P36 = Timeout Selection

This parameter sets the duration of the timeout used by the instrument during the operating mode.
tn.10= 10 seconds
tn 30= 30 seconds

Configure Output Safety Value

P37 = Conditions for Output Safety Value

This parameter is skipped if no control outputs are configured.
0 = No safety value (default).
1 = Safety value applied when overrange or underrange condition is detected.
2 = Safety value applied when overrange condition is detected.
3 = Safety value applied when underrange condition is detected.

P38 = Output Safety Value

This parameter is skipped if no control outputs are configured or P37 = 0.
This value can be set:

- From 0.0%to 100.0% when the controller is configured with one control output only.
- From -100.0% to 100.0% when the controller is configured with two control outputs.

NOTE: When the controller detects an out of range condition, it assigns the P38 value to the PID output but P18 and P20 are still active.

Configure Digital Filter

P39 = Digital Filter on the Displayed Value

noFL. = No filter.
FLtr = Filter enabled:

A first order digital filter with a time constant equal to:

- 4 seconds for TC and RTD inputs.
- 2 seconds for linear inputs.

P40 = Digital Filter on the Retransmitted Value

This parameter is available only if P5 = PV.rt.
noFL. = No filter.
FLtr = Filter enabled:

A first order digital filter with a time constant equal to:

- 4 seconds for TC and RTD inputs.
- 2 seconds for linear inputs.

Configure Control Action

P41 = Control Action Type

This parameter is skipped if no control outputs are configured.
Pid = The process is controlled by PID action.
Pi. = The process is controlled by PI action.

Configure Anti-WIndup

P42 = Anti-Reset-Windup

Range: From -30% to +30% of the proportional band.

NOTE: A positive setting increases the high limit of the anti-reset-windup (above set point) while a negative value decreases the low limit of the anti-reset-windup (below set point).

This completes the advanced configuration procedure. The instrument shows “COnF.” To enter operating mode, proceed to page 19.

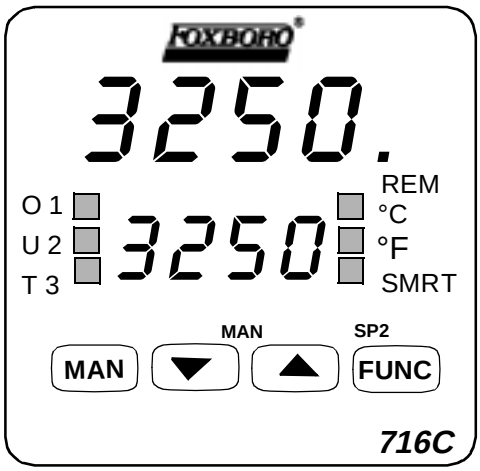
4. Operation

Operating Mode

To put the instrument into operating mode:

1. Remove the instrument from its case.
2. Set switch V101 to the closed position.
3. Reinsert the instrument in its case.
4. Switch on the instrument.

Display Function



The upper display shows the measured value; the lower display shows the programmed set point (this is the "normal display mode").

NOTE: When the rate of change (Grd1, Grd2) is used, the displayed set point may be different from the operating set point.

You can change the information on the lower display as follows:

- Press and hold the FUNC key for 3 seconds. The lower display then shows an "r." followed by the output power of the reverse acting control output (from 0 to 100%).
- Press the FUNC key again. The lower display shows "d." followed by the output power of the direct acting control output (from 0 to 100%).
- Press the FUNC key again. The display returns to "normal display mode."

NOTE: Two power outputs are displayed only if the relative function has been previously configured.

If no keys are pressed within the timeout period (see "P36 = Timeout Selection" on page 17), the display automatically returns to the "normal display mode."

In order to keep the desired information continuously on the lower display, press the "Δ" or "∇" keys to stop the timeout. To return to the "normal display mode," press the FUNC key again.

Indicators

REM ON when remote set point is selected.

°C ON when the process variable is shown in degrees Celsius.

°F ON when the process variable is shown in degrees Fahrenheit.

SMRT Flashes during autotuning (Smart AT).
ON steadily when autotuning is active.

OUT1 Flashes with a duty cycle proportional to the linear output value.

OUT2 ON when Output 2 is ON or Alarm 1 is in the alarm state.

OUT3 ON when Output 3 is ON or Alarm 2 is in the alarm state.

Other functions are shown by decimal points:

a. When the decimal point to the right of the upper display is flashing, the instrument is in the RMT condition (functions and parameters are controlled via serial link).

b. When the decimal point to the right of the lower display is flashing

- At a slow rate, SP2 is being used.
- At a fast rate, a set point from the serial link is being used.

c. When the decimal point to the right of the second digit of the lower display is flashing at a slow rate, the instrument is in the MANUAL mode.

Operating Key Functions

FUNC =Press to store the new setting of the selected parameter and display the next parameter (in increasing order).

MAN = Press to scroll back through the parameters without storing the new setting.

Δ = Press to increase the setting of the selected parameter.

∇ = Press to decrease the setting of the selected parameter.

NOTE: A 10 or 30 second timeout (see "P36 = Timeout Selection" on page 17*) can be selected for parameter modification. If no keys are pressed during this time period, the instrument goes to the "normal display mode" and the last parameter is NOT changed.*

Enable/Disable the Control Output

With the instrument in the "normal display mode," press and hold Δ and FUNC (for 5 seconds) to disable the control outputs. The device then functions as an indicator. All control outputs are then OFF and the word OFF is shown in the lower display (note that the outputs may be affected by parameters P18 and P20). Alarms are then in a "non-alarm" condition.

The alarm output condition depends on the alarm action type (see "P19 = Displayed Value of the Main Power Output" on page 14 through "P21 = Displayed Value of the Power Output for the Secondary Control Output" on page 14).

To restore the control status, press and hold (for 5 seconds) the Δ key and the FUNC key a second time. If the alarm standby function has been configured, alarms respond as though it were a powerup condition.

SP/SP2 Selection

The operating set point (SP or SP2) can be switched only by an external contact (terminals 14 and 15).

Manual Function

The MANUAL mode can be accessed (if P34 = On) by pressing the MAN key for 1 second. The command is accepted and executed only if the display is in the "normal display mode." When in MANUAL mode, the MAN LED is lit and the lower display shows the power output values. The value of the reverse acting output is shown in the two most significant digits and the value of the direct acting output (if present) is shown in the two least significant digits. The decimal point between the two values flashes to indicate the instrument is in MANUAL mode.

NOTE: "□□." is used for "rEV" = 100.
"□□ ." is used for "air" = 100.

The power output can be modified by using the Δ and ∇ keys. The output resolution is 1%. Press and hold (for 2 seconds) the MAN key again to return the device to the AUTO mode.

The transfer from AUTO to MANUAL and back is bumpless (this function is not available if integral action is excluded). If the transfer from AUTO to MANUAL occurs during the first part of the autotuning (Smart AT) algorithm (TUNE), it returns to MANUAL in the second part of the autotuning algorithm (ADAPTIVE).

At powerup, the device is in the AUTO mode or as it was left prior to power shutdown (depending on P35).

NOTE: When startup occurs in the Manual mode with power output set to 0, the control outputs are set in accordance with the following formula:
"rEv" output – "dir" output = 0.

Set Point Access

When the device is in AUTO mode and in the "normal display mode," you can directly access either set point (SP or SP2).

1. Press ∆ or ∇ (and hold for 2 seconds); the set point starts to change.
2. Once the desired setting is reached, wait 2 seconds before pressing a key. The new set point is then used.

NOTE: When SP2 is in operation but the device is LOCKed, direct access to SP2 is not allowed.

Serial Link

For more information on serial communication, refer to MI 018-579.

This instrument can be connected to a host computer by a serial link. The host computer can then put the device in either LOCAL (functions and parameters are controlled with the keys) or REMOTE (functions and parameters are controlled via serial link). REMOTE is signified by the LED labeled REM.

You can also download the device configuration through the serial link.

The conditions necessary to implement this function are:

1. Serial parameters from SEr1 to SEr4 are properly configured from the keys.
2. The device must be in OPERATING mode.

During downloading of the configuration, the device goes into open loop control with all outputs in the OFF state. At the end of the configuration procedure, the device performs an automatic reset and returns to closed loop control.

Autotuning (Smart AT) Function

Autotuning is used for automatic optimization of the control action. To enable autotuning, press the FUNC key until the "Snrt" parameter is shown. Press the ∆ or ∇ keys to set the display to "On" and then press the FUNC key.

The SMRT LED turns on or begins flashing in accordance with the selected algorithm. When autotuning is enabled, the control parameters can be displayed but not modified.

To disable autotuning, press the FUNC key again until "Snrt" parameter is shown. Press the ∆ or ∇ keys to set the display to "OFF" and press the FUNC key again. The SMRT LED then turns off. Once the autotuning is turned off, the instrument maintains the calculated control parameters, but allows the parameters to be modified.

NOTES:
1. When ON/OFF control is programmed (PB = 0), autotuning is disabled.
2. Autotuning enable/disable can be protected by the safety key (see "P27 = Alarm 2 Standby" on page 15*).*

Operating Parameters

1. From the "normal operating mode," press the FUNC key. The lower display shows the code and the upper display shows the setting or the status (ON or OFF) of the selected parameter.
2. Press the ∆ or ∇ keys to change the setting.
3. Press the FUNC key again; the instrument stores the new setting and goes to the next parameter.

Some of the following parameters may not appear, depending on the configuration.

Table 2. Operating Parameters

Parameter	Description
SP	Set Point (in engineering units).
Snrt	Autotuning (Smart AT) status. ON or OFF indicates the status of autotuning (enabled or disabled respectively). Set to ON to enable autotuning. Set to OFF to disable autotuning.
n.RSt	Manual reset of the alarms. Set to ON to reset the alarms.
nnn	Software key for parameter protection. ON = the instrument is LOCKED. OFF = the instrument is UNLOCKED. To switch from LOCK to UNLOCK, enter the P17 parameter setting. To switch from UNLOCK to LOCK, enter any number other than the P17 parameter setting.
SP2	Auxiliary set point (in engineering units).
AL1	Alarm 1 set point (in engineering units).
HSA1	Alarm 1 hysteresis (in % of P4 - P3 span).
AL2	Alarm 2 set point (in engineering units).
HSA2	Alarm 2 hysteresis (in % of P4 - P3 span).
Pb	Proportional band (in % of P4 - P3 span).
hYS	Hysteresis for ON/OFF control action (in % of P4 - P3 span).
ti	Integral time (in minutes and seconds [mm.ss]).
td	Derivative time (in minutes and seconds [mm.ss]).
IP	Integral pre-load 0 to 100% for 1 control output -100% (cooling) to 100% (heating)
CY2	Output 2 cycle time (in seconds). (See Note a.)
CY3	Output 3 cycle time (in seconds). (See Note a.)
rC	Relative Cooling gain (Output 2 gain). (See Note a.)
OLAP	Deadband/Overlap between H/C outputs (in % of the proportional band).

Table 2. Operating Parameters (Continued)

Parameter	Description
rL	Set Point low limit (in engineering units). From -100.0% (100% cooling) to 100.0% (100% heating).
rH	Set Point high limit (in engineering units).
Grd1	Ramp applied to a positive set point change (in units per minute).
Grd2	Ramp applied to a negative set point change (in units per minute).
OLH	Output high limit (in % of the output).
tOL	Time duration of the output power limit (in minutes).
rnP	Control output maximum rate of rise. Can be set with keys from 0.1% to 25.0% of the output per second. Above 25.0%, the display shows “InF,” meaning no ramp is imposed.

Note a: This parameter is visible only if configured as a control output.

5. Error Messages

Overrange, Underrange and Sensor Break Indications

The device is capable of detecting process variable faults (OVERRANGE, UNDERRANGE or SENSOR BREAK). When the process variable exceeds the span limits established by configuration parameter P1, an OVERRANGE condition appears as:

An UNDERRANGE condition appears as:

If P37 is not zero and an out of range condition is detected, the instrument operates in accordance with P37 and P38.

Output Action on Over/Underrange

When P37 is zero, the following conditions may occur:

- When the instrument is set for one output only and an OVERRANGE is detected, OUT 1 turns OFF (if reverse acting) or ON (if direct acting).
- When the instrument is set for heating/cooling and an OVERRANGE is detected, OUT 1 turns OFF and OUT 2 turns ON.
- When the instrument is set for one output only and an UNDERRANGE is detected, OUT 1 turns ON (if reverse acting) or OFF (if direct acting).
- When the instrument is set for heating/cooling and an UNDERRANGE is detected, OUT 1 turns ON and OUT 2 turns OFF.

The sensor break can be signaled as:

- For TC/mV input: OVERRANGE or UNDERRANGE (selected by a solder jumper)
- For RTD input: OVERRANGE
- For mA/V input: UNDERRANGE

NOTE: On the mA/V input the sensor break can be detected only when the range selected has a zero elevation (4 to 20 mA, 1 to 5 V or 2 to 10 V).

On the RTD input, a special test is provided to signal an OVERRANGE when input resistance is less than 15 ohms (short circuit sensor detection).

Error Messages

On powerup, the instrument performs a self-diagnostic test. When an error is detected, the lower display shows an "Err" indication and the upper display shows the code of the detected error.

Error Code	Description
100	EEPROM write error.
150	CPU error.
200	Attempt to write to protected memory.
201 - 2xx	Configuration parameter error. The two least significant digits show the number of the wrong parameter (ex. 209 Err shows an Error on P9 parameter).
299	Error on control output selection.
301	Input calibration error.
307	RJ input calibration error.
320	Analog retransmission calibration error.
400	Control parameter error.
500	Auto-zero error.
502	RJ error.
510	Calibration error.

Dealing with Error Messages

1. When a configuration parameter error is detected, repeat the configuration procedure of that specific parameter.
2. If error 400 is detected, simultaneously press the Δ and ∇ keys to load the default parameters and then repeat the control parameter setup.
3. For all the other errors, contact your Foxboro representative.

Default Parameters

Loading Default Operating Parameters

The control parameters can be loaded with predetermined default values. These are the settings loaded into the instrument prior to shipment from the factory. To load the default values, proceed as follows:

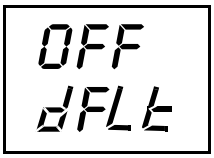
a. Internal switch V101 must be closed.

b. Autotuning (Smart AT) must be disabled.

c. The upper display will show the process variable and the lower display will show the set point.

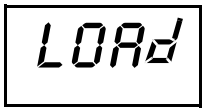
d. The instrument must be in "Local" and "Unlocked."

e. Hold down the ∇ key and press the Δ key; the display will show:



f. Press the Δ or ∇; the display shows:

g. Press the FUNC key; the display shows:



This indicates that the loading procedure has been initiated. After about three seconds, the loading procedure is complete and the instrument reverts to the "normal display mode."

The following is a list of the default operating parameters loaded during the above procedure:

Table 3. Default Operating Parameters List

Parameter	Default Value
SP	Minimum of range.
SnRT	Disabled.
n.SRt	Off.
nnn	Off.
SP2	Minimum of range.
A1, A2	Minimum of range for process alarms. 0 for deviation or band alarms.
HSA1, HSA2	0.1%.
PB	4.0%.
hS	0.5%.
ti	4.00 (4 minutes).
td	1.00 (1 minute).
IP	30.0 for one control output. 0.0 for two control outputs.
CY2-CY3	15 (seconds). If two control outputs are configured and OUT2 (OUT3) is "dir", the default will be: 10 seconds for P22 = AIr. 4 seconds for P22 = OIL. 2 seconds for P22 = H2O.

Table 3. Default Operating Parameters List (Continued)

Parameter	Default Value
rC	1.00 for P22 = AIr. 0.80 for P22 = OIL. 0.40 for P22 = H2O.
OLAP	0
rL	Initial scale value.
rH	Full scale value.
Grd 1	Infinite (step transfer).
Grd 2	Infinite (step transfer).
OLH	100%.
tOL	Infinite.
rnP	25%/second.

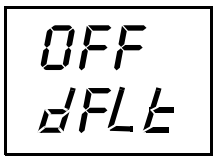
Default Configuration Parameters

The configuration parameters can be loaded with predetermined default values. These are the settings loaded into the instrument prior to shipment from the factory. To load the default values proceed as follows:

1. Internal switch V101 must be open.
2. The upper display shows:

3. Press the ∇ key; the lower display shows the firmware version:

4. Still holding the ∇ key, press the Δ key. The display shows:



5. Press the Δ key to select table 1 (European) or table 2 (American) default parameters; the display then shows:

6. Press FUNC key; the display then shows:

This indicates that the loading procedure has been initiated. After about 3 seconds the procedure is complete and the instrument reverts to the "COnF" display. The following is a list of the default configuration parameters:

Table 4. Default Configuration Parameter List

Parameter	Table 1 European	Table 2 USA
SEr 1	Ero	Ero
SEr 2	1	1
SEr 3	19200	19200
SEr 4	7E	7E
P1	0 to +1000° C	0 to + 1830°F
P2	----.	----.
P3	0	0
P4	400	1000
P5	rEV	rEV
P6	0-20	0-20
P7	0	0
P8	400	1000
P9	nonE	nonE
P10	H.A.	H.A.
P11	nonE	nonE
P12	H.A.	H.A.
P13	OPrt	OPrt
P14	0	0
P15	0.1	0.1
P16	0	0
P17	0	0
P18	norL	norL

Table 4. Default Configuration Parameter List (Continued)

Parameter	Table 1 European	Table 2 USA
P19	norL	norL
P20	norL	norL
P21	norL	norL
P22	Air	Air
P23	OFF	OFF
P24	rEV	rEV
P25	OFF	OFF
P26	rEv	rEv
P27	OFF	OFF
P28	0	0
P29	ON	ON
P30	2	2
P31	30.0	30.0
P32	1.0	1.0
P33	00.20	00.20
P34	ON	ON
P35	0	0
P36	10	30
P37	0	0
P38	0.0	0.0
P39	nO.FL	nO.FL
P40	nO.FL	nO.FL
P41	Pid	Pid

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