Tymkon™ Process Sequence Controller

Instruction Manual

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Our controllers are warranted against defects in materials and workmanship for the lifetime of the product. We will repair or replace, at our option, products that prove to be defective during the warranty period. All repairs will be made at the manufacturer's facility.

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Table of Contents

1. Description

1.1. Overview

Tymkon (pronounced 'time-con') is a series of process sequence controllers designed for batch-type process-control applications. All ***Tymkon*** controllers are based on a CMOS microprocessor as the major control element. This, along with other CMOS components and with the application of digital filtering, enables these controllers to operate reliably in the high electrical noise environments in which they often must function. Programming may be accomplished with front-panel controls or from a host computer. See the document named "*TicTalk™ Overview*" for a more complete discussion of how *Tymkon* relates to other members of the *Tic-Talk* series.

1.2. Tymkon Features

Following is a partial list of features included in most ***Tymkon*** configurations:

32 Recipes
64 Cycles per Recipe
16 or 32 Digital Outputs
8 or 16 Digital Interlock, Hold or Wait Inputs
8 or 16 Analog Outputs (0 to 5 volts)
8 or 16 Analog Inputs (0 to 5 volts)
64 Process Segments
32 Temperature Segments
8 Temperature Zones via EIA-422 Serial Port
Temperature Holdback Mode
4 Serial Communications Ports
Programmable Time Base (Minutes / Seconds)
Total-Time-Remaining Display
Programmable Branching
Programmable Alarms
Manual Abort
Manual Mode
Temperature Ramper Output (-10 to +10 millivolts)
Throttle Valve Communications
Host Communications
Custom Software Safety Modules
Power-up Diagnostics
Alphanumeric Status Messages
Simultaneous Programming and Operation
Completed Runs Counters
Power-Fail Software
Battery Backup for protection of process status
NAVRAM for protection of Recipes

1.3. Tymkon Configurations

A summary of the various levels of customization available in the ***Tymkon*** series is as follows:

- Hardware selection -- As described above, the first level of customization involves the selection of hardware appropriate to the application. Although the Tymkon series consists of many combinations of hardware, five major versions can be defined:

Configuration	Digital Outputs	Mounting
Vertical	16	Cabinet or Panel Mount
Vertical with Rotameter Interface	16	Cabinet or Panel Mount
Horizontal	16	Panel Mount
Horizontal	32	Panel Mount (10 MFC's)
Horizontal	32	Panel Mount (6 MFC's)

  Each basic configuration can be provided with or without analog outputs and inputs, temperature setpoint control via analog ramper, temperature setpoint control via a serial communications port, and/or EIA-232 host communications. The horizontal version with six MFC connectors also provides up to (16) internal pneumatic pilot valves, a flexible hardware interlock scheme and a signal tower connector. The horizontal version with ten MFC connectors also provides connectors for two RF generators, four Convectron gauges, a vacuum pump controller and a signal tower.

- Jumpers -- Some hardware modules provide jumper areas to adapt them to particular gas trays or sensors. An example of the parameters that may be jumpered is whether digital inputs accept contact closures to (**+**) or (**-**).

- Software variables -- In addition to the hardware variations, dozens of software options and variables can be customized to adapt a particular controller to its application.

- Custom Software Modules -- Depending on the application, a software module can be added to the Operating System ROM that monitors unsafe combinations of outputs and inputs and modifies the user program to maintain process safety.

- Front Panel insert -- A transparent insert can be provided for the front panel to identify the outputs and inputs in terms that are familiar to the user.

Considering the range of variations and options, it is difficult to describe the operation of a particular unit in an instruction manual. This manual represents an attempt to provide general instructions for use with the entire series. In many cases, an additional application note would supplement this manual.

2. INSTALLATION

This section of the manual contains instructions for installing ***Tymkon*** Process Sequence Controllers and related equipment. Included are the unit's input power requirements and interfacing requirements. Every ***Tymkon*** controller is fully tested before shipment and is guaranteed to operate in accordance with specifications. If a unit should appear to have been damaged in transit, notify the carrier and refer to the warranty at the front of this manual for further instructions.

2.1. Power Requirements

Most ***Tymkon*** controllers are supplied with a line cord mounted plug/transformer that supplies 9.0 VAC at 1.5 amperes from an input supply of 115 VAC, 50 or 60 Hertz. At the user's request, an alternate transformer can be provided to permit operation on 220 VAC.

An exception to the line cord mounted plug/transformer configuration is the Rotameter version of the ***Tymkon***. These units require a dual winding transformer or two single winding transformers in order to generate the 24 Volt DC required to power solenoid valves.

2.1.1. Power Wiring – I/O Board 9990080F

Most Tymkons manufactured after 2003 include a 4-pin Minifit connector for power entry. Two of the pins provide low voltage AC to the logic power supply and the remaining two pins provide low voltage AC for the power supply that powers the output relay coils. Each of these two power supplies requires approximately 1 amp at 9 Volts AC. In most cases, a single 9 Volt AC transformer can be used to both sections of the power supply. Jumper locations are provided on the power board near the connector to common the two supplies together if they are to be powered by a single transformer. Another option is to common the two supplies in the external wiring. The following table details the pinout of the 4-pin connector:

J10		**Pin Location ***
1	Logic Supply A	Lower Left
2	Logic Supply B	Lower Right
3	Relay Supply A	Upper Left
4	Relay Supply B	Upper Right

* Note: The Pin Locations are as viewed from the rear with the Tymkon standing vertical.

If a single transformer winding is being used to power both sections of the power supply, jumper pin 1 to pin 3 and pin 2 to pin 4. These connections can be made using the on-board jumpers or in the external wiring.

2.1.2. Chassis Mount Transformer

In some cases, a chassis mount transformer is provided. The standard chassis mount transformer has dual primary and dual secondary windings. A disadvantage of the chassis mount transformer is that the primary leads are exposed. Therefore, this transformer can only be used in installations where the transformer is mounted in a protected location where users come in contact with the wiring.

Two chassis mount transformers are available. Both versions are manufactured by MCI Transformer. Part number 4-49-5018 provides two 9-volt secondary windings and part number 4-49-5020 provides two 10-volt secondary windings. In installations where the Tymkon is powered from a 50-Hertz line, it is advisable to use the 10-volt version to help compensate for the reduced efficiency of the transformer at 50-Hertz.

Both versions of the chassis mount transformer have two primary windings. When the transformer is to operate at 220 VAC, connect the two primary coils in series. When the transformer is to operate at 110 VAC, connect the two primary coils in parallel.

The lugs on the 4-49-5018 and 4-49-5020 transformers are identified as follows:

Transformer Lug		
1	Primary Winding 1-A	
2	Primary Winding 1-B	
4	Primary Winding 2-A	
5	Primary Winding 2-B	
6	Secondary Winding 1-A	J10 Pin 1
7	Secondary Winding 1-B	J10 Pin 2
9	Secondary Winding 2-A	J10 Pin 3
10	Secondary Winding 2-B	J10 Pin 4

For operation at 110 VAC, connect one side of the input power to pins 1 and 4 and connect the other side of the input power to pins 2 and 5.

For operation at 220 VAC, connect one side of the input power to pins 1 and connect the other side of the input power to pins 5. Also, jumper pins 2 and 4 to connect the windings in series.

2.2. I/O Board Options

2.2.1. I/O Board 9990015C (w/ Terminal Lugs)

While most ***Tymkon*** models provide a multi-pin connector for interface wiring, connections on the older 9990015C board are made via 0.187" lugs on the printed circuit board. I/O functions are silk-screened onto the circuit board near the lugs and are not tabulated in this manual.

Each of the (16) relays on this board connects to three lugs. One of the lugs is labeled **C** for Common, one is labeled **NO** for Normally Open, and one is labeled NC for Normally Closed.

The digital inputs on this board are connected to two lugs each. The lugs labeled (**+**) are connected to the anodes of optical isolators through current limiting resistors, while the lugs labeled (**-**) are connected to the cathodes of the optical isolators. ***Tymkon*** controllers are ordinarily shipped with resistor values of 3300 ohms to permit operation from 5 volts DC through 24 volts DC. Please consult the factory for operation at other input voltages.

The control inputs on this board are labeled **RUN** (*Run/Hold*), **RES** (*Reset*) and **AL SIL** (*Alarm Silence*). These functions can be activated externally by providing contact closures to the lug labeled **GND**. Though these signals are debounced and pulled-up inside the ***Tymkon***, the user must be careful not to subject the inputs to unreasonable electrical noise.

Two signal lines are provided for an external buzzer. A Mallory Sonalert, P/N SC628, or equivalent may be connected to the pins labeled ALARM (**+**) and ALARM (**-**). The ALARM (**+**) terminal is connected directly to the unregulated DC supply, and the ALARM (**-**) terminal is driven by an NPN transistor. These terminals parallel the internal alarm.

2.2.2. I/O Board 9990089A & 9990270A (w/ 50-pin Communications Connector)

The most common ***Tymkon*** I/O board, 99900270A, provides a 50-pin communications connector for user interface. This type of connector is available both in flat cable and round cable types and has gained wide acceptance in the communications and instrumentation industries. It is used on multi-line telephone installations and is similar to the type specified in the IEEE-488 instrumentation standard. An older version of this board with the same functionality and pinout was identified as 9990089A.

On the ***Tymkon*** I/O board, the receptacle end of the communications connector set is mounted on the rear panel and the plug end is installed on the cable of the equipment being controlled. This configuration allows the user to secure the connecting cable to the ***Tymkon*** using a screw-lock version of the plug connector. A typical cable-end connector is Amphenol part number 57-33500-1.

I/O boards 9990089A and 9990270A provide (16) SPST relays for the digital output signals. The contacts of each relay are protected by a suppression diode and can be individually jumpered to provide a switch closure to the negative or the positive side of the user’s power supply. The *Normally Open* contact of each relay is connected to a separate pin on the 50-pin connector as listed below.

Each digital input on this board is also connected to a separate pin on the 50-pin connector. As with the digital outputs, the (8) digital inputs can be individually configured to accept switch closures to either the negative or the positive side of the user’s supply. A 3300-ohm current limiting resistor in series with each input permits operation from 5 volts DC through 24 volts DC. Please consult the factory for operation at other input voltages.

In a typical application, the user specifies the input-output requirements and the manufacturer jumpers the interface board to satisfy those requirements.

The control inputs on this board are labeled **RUN INPUT** (*Run/Hold*), **RESET INPUT** (*Reset*), **ALARM SILENCE INPUT** (*Alarm Silence*) and **ABORT INPUT** in the table below. These functions can be activated externally by providing contact closures to the pin labeled **DIGITAL GROUND**. Though these signals are debounced and pulled-up inside the ***Tymkon***, the user must be careful not to subject the inputs to unreasonable electrical noise.

Two signal lines are provided for an external buzzer. A Mallory Sonalert, P/N SC628, or equivalent may be connected to the pins labeled **ALARM (+) OUTPUT** and **ALARM (-) OUTPUT**. The **ALARM (+) OUTPUT** pin is connected directly to the unregulated DC supply, and the **ALARM (-) OUTPUT** pin is driven by an NPN transistor. These terminals parallel the internal alarm.

Following is a pin assignment table listing the functions brought out to the 50-pin connector. The pins have been grouped into functional modules to ease installation and to physically isolate dissimilar signals. In addition to the communications pin numbers, the table also lists the conductor number of each signal as it would appear on a ribbon cable. The column containing the IDC (Insulation Displacement Connector) ribbon cable conductor number is labeled “IDC”.

Pin	Function	IDC
1	ANALOG OUTPUT F	1
2	ANALOG OUTPUT E	3
3	ANALOG OUTPUT D	5
4	ANALOG OUTPUT C	7
5	ANALOG OUTPUT B	9
6	ANALOG OUTPUT A	11
7	ANALOG OUTPUT 9	13
8	ANALOG OUTPUT 8	15
9	ANALOG COMMON	17
10	DIGITAL GROUND	19
11	ALARM SILENCE INPUT	21
12	RUN INPUT	23
13	DIGITAL INPUT 7	25
14	DIGITAL INPUT 5	27
15	DIGITAL INPUT 3	29
16	DIGITAL INPUT 1	31
17	OUTPUT F (NO)	33
18	OUTPUT D (NO)	35
19	OUTPUT B (NO)	37
20	OUTPUT 9 (NO)	39
21	OUTPUT 7 (NO)	41
22	OUTPUT 5 (NO)	43
23	OUTPUT 3 (NO)	45
24	OUTPUT 1 (NO)	47
25	+ SUPPLY (+5 to +40 VOLTS)	49

Pin	Function	IDC
26	ANALOG INPUT F	2
27	ANALOG INPUT E	4
28	ANALOG INPUT D	6
29	ANALOG INPUT C	8
30	ANALOG INPUT B	10
31	ANALOG INPUT A	12
32	ANALOG INPUT 9	14
33	ANALOG INPUT 8	16
34	ALARM (-) OUTPUT	18
35	ALARM (+) OUTPUT	20
36	ABORT INPUT	22
37	RESET INPUT	24
38	- SUPPLY (-5 to -40 VOLTS)	26
39	DIGITAL INPUT 6	28
40	DIGITAL INPUT 4	30
41	DIGITAL INPUT 2	32
42	DIGITAL INPUT 0	34
43	OUTPUT E (NO)	36
44	OUTPUT C (NO)	38
45	OUTPUT A (NO)	40
46	OUTPUT 8 (NO)	42
47	OUTPUT 6 (NO)	44
48	OUTPUT 4 (NO)	46
49	OUTPUT 2 (NO)	48
50	OUTPUT 0 (NO)	50

2.2.2.1. Connecting to: MRL/Argus 581 Gas Panel Interface

In applications where the ***Tymkon*** is used with an Argus 581 Gas Panel Interface, the ***Tymkon*** relay board must be jumpered to provide contact closures to the (**+**) side of the 5-volt supply in the 581. To provide the ***Tymkon*** with 5 volts to be switched, connect the +5 volt supply from the 581 to pin 25 on the ***Tymkon*** relay board and connect the 5 volt return (ground) from the 581 to pin 38 on the ***Tymkon*** relay board.

The 581 provides a single interlock output that can be connected, to *Digital Input 0* on the ***Tymkon***. This interlock signal, however, is referenced to a different power supply than the outputs. In order to accommodate the two separate power supplies, the cathode of the optical isolator for *Input 0* is jumpered on the relay board such that it is available on pin 42 of the I/O connector. The anode of the optical isolator for Input 0 is then jumpered on the relay board such that it is available on pin 13 of the I/O connector. (Pin 13 is usually connected to Input 7 which is unused in this application.)

Request a drawing of the relay board from ITS for more explicit jumper details.

2.2.2.2. Connecting to: ITS Model 801, 803 or 804 Gas Panel Interface

In applications where the ***Tymkon*** is used with Integrated Time Systems, Models 801, 803 or 804 Gas Panel Interfaces, the ***Tymkon*** relay board must be jumpered to provide contact closures to the (**-**) side of the 24-volt power supply. In addition, the inputs on the relay board must be jumpered (**+**) so as to accept contact closures to 24 volt return from the GPI.

2.2.3. I/O Board 9990077A (w/ 37-Pin / 9-Pin Female ‘D’ Connectors)

An older, less common interface configuration includes a 37-pin ‘D’ connector for input/output signals and a 9 pin ‘D’ connector for control signals. This configuration does not include relays for output signals; instead, the solid-state output signals from the microprocessor output latch/driver are brought out to the 37-pin connector.

A separate diode bridge and filter capacitor is provided on this output board to convert an AC voltage (supplied by the user) to the DC voltage required by the user’s solenoids or relays. If this feature is used, the AC power source must be wired to terminal lugs on the output board (TB1 Pins 1 and 2). Alternately, an external DC source may be used to power the outputs. In this case, the positive side of the external DC supply must be connected to the Output Common pin on the 37-pin connector and the negative side must be connected to the Ground pin on the 37-pin connector. When using either an AC or DC power source, the resultant DC voltage must be limited to a maximum of 40 volts to protect the output drivers.

The DC power supply for the outputs is monitored for power line failures. Therefore, the controller will not function until this supply is connected. If this feature is undesirable and if an external DC supply is being used, the user may jumper the AC input lugs (TB1 Pins 1 and 2) to the lugs, which provide power to the logic supply (TB1 Pins 4 and 5). Thus, when the 37-pin connector is disconnected and the DC power source is removed, the power line monitor will still see a low voltage from the logic supply transformer and the controller will continue to function.

The (**+**) terminal of each process input on this board is accessible on the 37-pin connector. Each input pin is connected through a current-limiting resistor to the anode of an optical isolator. The cathode of all of the isolators is commoned together to a pin labeled **INPUT COMMON**. The eight current-limiting resistors are installed on a socketed component carrier on an internal printed circuit board. ***Tymkon*** controllers are ordinarily shipped with resistor values of 3300 ohms for operation from 5 through 24 Volts DC. Please consult the factory for operation at other input voltages. The internal unregulated DC power supply, which is available at the **ALARM (+) OUTPUT** and **DIGITAL GROUND** terminals, can optionally be used to power the process inputs.

The control inputs on this board are labeled **RUN INPUT** (*Run/Hold*), **RESET INPUT** (*Reset*), **ALARM SILENCE INPUT** (*Alarm Silence*) and **ABORT INPUT** and are available on a 9-pin ‘D’ connector. These functions can be activated externally by providing contact closures to the pin labeled **DIGITAL GROUND**. Though these signals are debounced and pulled-up to +5 volts inside the ***Tymkon***, the user must be careful not to subject the inputs to unreasonable electrical noise.

Two signal lines are provided on the 9-pin ‘D’ connector for an external buzzer. A Mallory Sonalert, P/N SC628, or equivalent may be connected to the pins labeled **ALARM (+) OUTPUT** and **ALARM (-) OUTPUT**. The **ALARM (+) OUTPUT** pin is connected directly to the unregulated

DC supply, and the **ALARM (-) OUTPUT** pin is driven by an NPN transistor. These terminals parallel the internal alarm.

Following is a pin assignment table listing the functions brought out to the connectors.

37 Pin	Function
1	OUTPUT COMMON (+)
2	OUTPUT F
3	OUTPUT E
4	OUTPUT D
5	OUTPUT C
6	OUTPUT B
7	OUTPUT A
8	OUTPUT 9
9	OUTPUT 8
10	OUTPUT COMMON (+)
11	OUTPUT 7
12	OUTPUT 6
13	OUTPUT 5
14	OUTPUT 4
15	OUTPUT 3
16	OUTPUT 2
17	OUTPUT 1
18	OUTPUT 0
19	ALARM (-)

37 Pin	Function
20	ANALOG OUTPUT A
21	ANALOG OUTPUT B
22	ANALOG OUTPUT C
23	ANALOG OUTPUT D
24	ANALOG OUTPUT E
25	UNUSED
26	ANALOG COMMON
27	DIGITAL GROUND
28	ALARM (+) OUTPUT
29	INPUT COMMON (+5 to +40 VOLTS)
30	DIGITAL INPUT 0
31	DIGITAL INPUT 1
32	DIGITAL INPUT 2
33	DIGITAL INPUT 3
34	DIGITAL INPUT 4
35	DIGITAL INPUT 5
36	DIGITAL INPUT 6
37	DIGITAL INPUT 7

9 Pin	Function
1	RUN INPUT
2	RESET INPUT
3	ALARM SILENCE INPUT
4	ALARM (-)
5	ALARM (+)

9 Pin	Function
6	ABORT INPUT
7	UNUSED
8	UNUSED
9	DIGITAL GROUND

2.2.4. Rotameter Gas Panel Interface

This section describes an interface board that simplifies installations in which ***Tymkon's*** are used to control Rotameter-type gas panels. The circuit board and schematic for the board are numbered 9990441.

The interface includes a torch temperature monitor circuit, a 24-volt power supply and connectors for miscellaneous system components.

2.2.4.1. Power Supplies

An on-board 24-volt power supply is provided for various interface functions.
To avoid ground loops that might corrupt analog readings, the 24-volt return, the digital ground and the analog common are routed separately and share only a single common tie point. It is advisable to maintain this separation in any external circuitry if possible.

2.2.4.2. Temperature Monitor – TC1

An optional monitor circuit is available for the interface board to allow for temperature interlocks on burnt Hydrogen systems. The circuit accepts an input signal from a Type 'K' thermocouple and performs automatic cold-junction compensation. The resulting signal is amplified and presented to an A/D converter channel (Analog Input 9) on the Tymkon Power Board.

2.2.4.3. Valve Actuation Connector – J8

The *Valve Actuation* connector is a 25-pin female 'D' connector for solenoid control. The connector outputs contact closures to 24-volt return. The (8) digital outputs are controlled via ***Tymkon*** outputs 2 through 9. Also provided on this connector are (9) **+24V** pins for the common side of the solenoids.

Pin	FUNCTION
1	
2	Digital Output 2
3	Digital Output 4
4	Digital Output 6
5	Digital Output 8
6	
7	24 V Return
8	24 V Return
9	+24 V
10	+24 V
11	+24 V
12	+24 V
13	+24 V

Pin	FUNCTION
14	
15	Digital Output 3
16	Digital Output 5
17	Digital Output 7
18	Digital Output 9
19	
20	24 V Return
21	24 V Return
22	+24 V
23	+24 V
24	+24 V
25	+24 V

2.2.4.4. Loader Connector – J10

A 9-pin female 'D' connector provides the signals required for boat loader control. A **LOAD** signal is generated by a relay contact to **24V RETURN** and is controlled by digital output 0. Similarly, digital output 1 generates an **UNLOAD** command. The loader limit switches are monitored by isolated digital inputs 0 (**Boat-In-Complete**) and 1 (**Boat-Out-Complete**). The boat loader must provide contact closures to **24V RETURN** to energize the inputs. A software variable permits the ***Tymkon*** to be configured for normally-closed or normally-open limit switches.

An analog output and analog input signal are included on the *Loader* connector to permit programmable boat speeds. The analog setpoint for boat speed control is programmed via ***Tymkon*** output 8. If the boat loader does not generate a 0 to 5 volt speed feedback signal, the **SPEED ACTUAL** pin should be jumpered to the **SPEED SETPT** pin to satisfy the ***Tymkon's*** analog input requirements. The **ANAL COMMON** pin serves as a reference for the analog signals.

Note: The boat loader electronics must not connect the 24-volt control and limit switch signals to the speed control signals. The two power supplies are electrically isolated from each other and must remain so for proper operation.

Pin	FUNCTION
1	Digital Output 0 (LOAD)
2	Digital Output 1 (UNLOAD)
3	24V RETURN
4	Analog Output 8 (Speed)
5	Analog Common

Pin	FUNCTION
6	+24 VDC
7	Digital Input 0 (BIC)
8	Digital Input 1 (BOC)
9	Analog Input 8 (Position)

2.2.4.5. Sensor Connector – J9

A 9-pin female 'D' connector provides for five input signals from miscellaneous flow, pressure or door switches.

A sensor must provide a contact closure to **24V RETURN** to energize the appropriate digital input. Software variables permit the ***Tymkon*** to be configured for any combination of normally-closed or normally-open switches. In addition, software safety patches can monitor these inputs to prevent unsafe process conditions.

Two digital outputs (A & B) are also available on the sensor connector, one as a Form 'C' relay and one as a Form 'A' relay. Access to the 24 VDC power supply is provided so that the relays can be wired to switch +24V or 24V RETURN as required.

Pin	FUNCTION
1	24V RET
2	Digital Input 2
3	Digital Input 3
4	Digital Input 4
5	Digital Input 5
6	Digital Input 6
7	Relay Common
8	+24 VDC

Pin	FUNCTION
9	24V RET
10	Analog Output 9
11	Analog Common
12	Analog Input 9
13	Relay A (Nor Open)
14	Relay A (Nor Closed)
15	Relay B (Nor Open)

2.3. Serial Communications Adapters

The Tymkon CPU board supports four communications adapters each of which terminates at a 6-pin RJ-12 female connector on the CPU board. An exception is the fourth port, Port D, which terminates at two RJ-12 connectors to permit daisy chaining a host connection from Tymkon to Tymkon. Available communications adapters support EIA-232, EIA-485 (2-wire & 4-wire) and EIA-422 (4-wire) in both isolated and non-isolated versions. These various adapters may be installed in any combination as required by the application.

The following table details the available plug-in comm adapters:

Part #	Board	Function	Description
810-0381	9990381	EIA-232	w/ Hardware Handshake
810-0382	9990382	EIA-232, Isolated	w/ Hardware Handshake
810-0383	9990383	EIA-422/485, 2/4 Wire	Half/Full Duplex, Master/Slave
810-0384	9990384	EIA-485, 4 Wire, Isolated	Half/Full Duplex, Master/Slave
810-0385	9990385	EIA-485, 2 Wire, Isolated	Half Duplex
810-0386	9990386	EIA-422, 4 Wire, Isolated	Full Duplex, Master

The following table summarizes typical comm adapter applications:

Application	Part #	Port	Function
Host Computer	810-0382	D	EIA-232, Isolated
Eurotherm 808/2408	810-0383	B	EIA-422/485, 2/4 Wire
Watlow Anafaze PPC-2000	810-0384	B	EIA-485, 4 Wire, Isolated
Millipore AC-X Throttle Control	810-0382	C	EIA-232, Isolated
MKS-651 Throttle Control	810-0382	C	EIA-232, Isolated
Drive Controller, Quick Controls	810-0383	A	EIA-422/485, 2/4 Wire

2.4. Host Computer Interface

The Tymkon connects to a Host Computer via an Isolated EIA-232 Comm Adapter, part number 810-0382. Using isolated adapters allows each Tymkon to reference a dedicated Analog Common. (See page 12 for a list of available communication adapters.)

The simplest, highest performance way to connect a single Tymkon to a computer is to use a standard EIA-232 serial port on the computer. Most PC's have at least (2) comm ports and they always support EIA-232. This standard supports hardware handshake and allows for high baudrate communications with little risk of corrupted messages. The limitation of this approach is that a separate serial port is required for each Tymkon to be connected (the EIA-232 standard does not support multidrop connections). ISA or PCI serial boards that install easily into most PC's and contain (4) or more serial ports are available from several different vendors.

The Tymkon communicates with a Host Computer using the following communications parameters:

Baud Rate:	115,200
Parity:	None
Data Bits:	7
Stop Bits:	1

The Tymkon CPU board has a 6-pin RJ-12 female connector on Port D for connection to the EIA-232 DTE Comm Port on the Host Computer. The extension cable between the Tymkon and the Host is a standard serial extension cable with a 9-pin female 'D' on the end that plugs into the Host and a 9-pin male 'D' on the end that plugs into an adapter that plugs into the Tymkon. The adapter consists of a 9-pin female 'D' mated to a female 6P6C RJ12 described below. A short 'straight-thru' modular telephone cable (Pan Pacific part number DC-506P-3SV, or equivalent) connects the adapter to the Tymkon.

RJ-12 to 9-pin female 'D' adapter			
RJ-12 on Tymkon	Wire Color (inside adapter)	9-Pin 'D' Connector To PC	Signal
1	Blue	5	SG
2	Yellow	3	TDX from PC to Tymkon
3	Green	2	RDX from Tymkon to PC
4	Red	7	RTS from PC to Tymkon
5	Black	8	CTS from Tymkon to PC
6	White		

Note: Pin 1 on the RJ-12 receptacle is on the left when looking into the opening of the receptacle with the contacts across the top and the catch for the plug's latch on the bottom. Pins are labeled consecutively from left to right. Note: 'straight-thru' means that pin 1 goes to pin 1 (which looks reversed when the connectors are held end-to-end).

In some cases, a female 'D' connector is mounted directly on the Tymkon enclosure. In that case, a short RJ12 cable with tinned leads (available from L-COM as part number TDC029-1) is soldered to a female 9-pin 'D' that is then secured to the enclosure. The pinout of the connector is as follows:

RJ-12 plug to 9-pin female 'D' cable			
RJ-12 Plug	Wire Color (inside adapter)	9-Pin 'D' Connector To PC	Signal
6	Blue		
5	Yellow	8	CTS from Tymkon to PC
4	Green	7	RTS from PC to Tymkon
3	Red	2	RDX from Tymkon to PC
2	Black	3	TDX from PC to Tymkon
1	White	5	SG

2.5. Temperature Setpoint Control

2.5.1. Temperature Control via Eurotherm Models 808/847/2216/2408

The Tymkon CPU board has a 6-pin RJ-12 female connector for connection to the serial port on the Eurotherm 808/847/2216/2408 temperature controllers.

Eurotherm temperature controllers require a communications module option to enable remote setpoint control. These modules are available from Eurotherm in both EIA-232 and EIA-422 versions. The generic Eurotherm 'EIA-422' option may be used to implement an EIA-485 (2-wire & 4-wire) or EIA-422 (4-wire) interface. The preferred interface between the Tymkon and one or more Eurotherm temperature controllers is 4-wire EIA-485. This interface allows a single communications port at the Tymkon to be connected to from one to eight temperature controllers using device ID's to identify specific controllers.

Since the Eurotherm's serial ports are individually isolated, the non-isolated type of adapter, part number 810-0383, may be used at the Tymkon. Tymkon Port B, the second of four serial ports, is typically used for temperature control. (See page 12 for a list of available comm adapters.)

The Tymkon communicates with the Eurotherm controllers using the Eurotherm default communications parameters:

Baud Rate:	9,600
Parity:	Even
Data Bits:	7
Stop Bits:	1

The extension cable between the Tymkon and the Eurotherm is a 'straight-thru' modular telephone cable (DC-506P-3SV, or equivalent). The other end of the cable plugs into an adapter that consists of a 9-pin female 'D' mated to a female 6P6C RJ-12 as described below. A 9-pin male 'D' connector then plugs into the adapter and provides individual wires to connect to the Eurotherm terminal block. Note that the two transmit wires should be twisted together into a wire pair from the adapter to the Eurotherm to improve noise immunity. Likewise, the two receive wires should be twisted together (Note the use of the word 'twisted' – not 'shorted').

Pin 1 on the RJ-12 receptacle is on the left when looking into the opening of the receptacle with the contacts across the top and the catch for the plug's latch on the bottom. Pins are labeled consecutively from left to right. Note: 'straight-thru' means that pin 1 goes to pin 1 (which looks reversed when the connectors are held end-to-end).

If the length of the wires between the Tymkon and the most distant temperature controller is more that 10 feet, the transmit wires from the Tymkon must be terminated with a 120 ohm resistor (½ watt) at the Eurotherm. Whether the Tymkon signal is being multi-dropped to more than one temperature controller or not, the termination resistor should be installed across pins HB & HC of the temperature controller most far from the Tymkon.

Eurotherm 808/847 w/ EIA-422A Comm Adapter Connected as 4 Wire, EIA-422, Isolated at Eurotherm's Tymkon is Master, Up to (8) 808/847's are Slaves Tymkon w/ Model 810-0383 Comm Adapter					
RJ-12 to 9-pin female 'D' adapter			9-pin male 'D' to terminal block		
RJ-12 on Tymkon	Wire Color (inside adapter)	9-Pin 'D' Connector To 808/847	Signal	Wire from Adapter to	808/847 Terminal Block
4	Red	7	RDX+	Yellow	14
3	Green	2	RDX-	Purple	15
5	Black	8	TDX+	Gray	12
2	Yellow	3	TDX-	Blue	13
1	Blue	5	GND	Black	11
				Jumper	16 to 17

Eurotherm 240X w/ Model SUB24/FE RS422 Comm Adapter (EI-Bisync) Eurotherm 240X w/ Model SUB24/FM RS422 Comm Adapter (MODBUS) Connected as 4 Wire, EIA-422, Isolated at Eurotherm's Tymkon is Master, Up to (8) 240X's are Slaves Tymkon w/ Model 810-0383 Comm Adapter					
RJ-12 to 9-pin female 'D' adapter			9-pin male 'D' to terminal block		
RJ-12 on Tymkon	Wire Color (inside adapter)	9-Pin 'D' Connector To 2408	Signal	Wire from Adapter to	2408 Terminal Block
4	Red	7	RDX+	Yellow	HB
3	Green	2	RDX-	Purple	HC
5	Black	8	TDX+	Gray	HE
2	Yellow	3	TDX-	Blue	HF
1	Blue	5	GND	Black	HD
				Jumper	V+ to V-

Eurotherm 240X w/ Model RS485 Comm Adapter Connected as 2 Wire, EIA-485, Isolated at Eurotherm's Tymkon is Master, Up to (8) 240X's are Slaves Tymkon w/ Model 810-0383 Comm Adapter					
RJ-12 to 9-pin female 'D' adapter			9-pin male 'D' to terminal block		
RJ-12 on Tymkon	Wire Color (inside adapter)	9-Pin 'D' Connector To 2408	Signal	Wire from Adapter to	2408 Terminal Block
4	Red	7	A+	Yellow	HE
3	Green	2	B -	Purple	HF
5	Black	8			
2	Yellow	3			
1	Blue	5	GND	Black	HD
				Jumper	V+ to V-

Note: Dual input Eurotherm controllers must be properly configured to allow the Tymkon to select the appropriate PID table. See page 46 for details.

Note: The following Eurotherm part number may be used as a reference when specifying a temperature controller for use with the Tymkon: 2408CC/VH/LH/XX/WP/XX/FE/XX/ENG.

2.5.2. Temperature Control via Watlow Anafaze PPC-2000

Port 2 on the Anafaze temperature controller provides a 4-wire EIA-485 interface. This allows a single communications port at the Tymkon to be connected to one or more temperature controllers using device ID's to identify specific controllers. Since each Anafaze supports up to (48) PID zones, each Tymkon is connected to a single PPC-2000 whose device ID is set to '1'.

Since the Anafaze's serial ports are not isolated, the isolated type of adapter, part number 810-0384, should be used at the Tymkon. Tymkon Port B, the second of four serial ports, is typically used for temperature control. (See page 12 for a list of available comm adapters.)

The extension cable between the Tymkon and the Anafaze is a 'straight-thru' modular telephone cable (DC-506P-3SV, or equivalent). One end of the cable plugs into an adapter that consists of a 9-pin female 'D' mated to a female 6P6C RJ-12. The other end of the cable plugs into a second adapter that consists of a 9-pin male 'D' mated to a female 6P6C RJ-12. The pinout of both adapters is provided below.

Pin 1 on the RJ-12 receptacle is on the left when looking into the opening of the receptacle with the contacts across the top and the catch for the plug's latch on the bottom. Pins are labeled consecutively from left to right. Note: 'straight-thru' means that pin 1 goes to pin 1 (which looks reversed when the connectors are held end-to-end).

Anafaze PPC-2010, Port 2, connected to Tymkon using 4-wire EIA-485, Model 810-0384 Isolated Comm Adapter. Tymkon is Master, Anafaze is Slave.							
RJ-12 to 9-pin female ‘D’ adapter				9-pin male ‘D’ adapter to RJ-12			
RJ-12 on Tymkon	Wire Color (inside adapter)	9-Pin ‘D’ female Connector	Signal (Tymkon’s terminology)	Signal (Anafaze’s terminology)	9-Pin ‘D’ male Connector	Wire Color (inside adapter)	RJ-12 on PPC-2010
6			COMMON	COMMON			
4	Red	7	TX+	TXA/TDA/TX-	7	Black	5
3	Green	2	TX-	TXB/TDB/TX+	2	Yellow	2
5	Black	8	RX+	RXA/RDA/RX-	8	Red	4
2	Yellow	3	RX-	RXB/RDB/RX+	3	Green	3
1	Blue	5	COMMON	COMMON	5	Blue	1

If the 810-0383 non-isolated adapter is used instead of the isolated version, the five jumpers on the 810-0383 comm adapter must be installed as follows:

JP1NOR
JP2FULL
JP3NOR
JP4500k
JT1This is a 2-pin jumper which should have a shunt installed.

The Tymkon communicates with the PPC using the PPC’s default communications parameters:

Baud Rate:	19,200
Parity:	Even
Data Bits:	8
Stop Bits:	1

2.5.3. Temperature Control via Analog Temperature Ramper 9990071E

This option was first implemented when digital temperature controllers were not yet available. It is typically not used in new installations and is described here for reference purposes only.

When temperature ramping is implemented via the 16-bit analog output board, the setpoint voltage is available on a 2-pin MOLEX connector. The mating connector, part number 03 06 1023, is supplied with the ***Tymkon*** as are the required pins, (1) part number 02 06 2103 and (1) part number 02 06 1103. The polarity of the ramper signal can be determined empirically to suit conventions in place at the particular facility. In most installations, the ramper is wired to produce increased temperatures when positive setpoints are programmed.

In applications where the ramper output provides an offset to the control thermocouple, the ramper signal from the ***Tymkon*** should be run to the terminal block of the center-zone temperature controller using ordinary 20 A.W.G. copper wire, not T/C compensated wire. This prevents the formation of extraneous thermocouples except where the cold junction compensation is performed at the temperature controller.

2.5.4. Temperature Control via Tempress DTC

A Tymkon accessory board provides up to (8) additional relay outputs on any 16-output Tymkon. This board, part number 9990366, sub-assembly 810-0050, may be configured to provide recipe select signals for the DTC Temperature Controller. The DTC Temperature Controller has a set of (4) digital inputs that may be used to select one of 16 possible temperature-control 'recipes'. The control signals for the DTC exit the Tymkon on a 15-conductor ribbon cable. Pinout of the 15-pin male 'D' connector at the end of the ribbon cable is as follows:

Tymkon Function	Tymkon Connector	DTC Function	DTC Pin	15 Pin 'D'
DO24 N.C.	P1.1 ('IDC')			1
DO24 N.O.	P1.2 ('IDC')			9
DO24/25 COM	P1.3 ('IDC')			2
DO25 N.O.	P1.4 ('IDC')			10
DO25 N.C.	P1.5 ('IDC')			3
DO26 N.C.	P1.6 ('IDC')			11
DO26 N.O.	P1.7 ('IDC')			4
DO26/27 COM	P1.8 ('IDC')			12
DO27 N.O.	P1.9 ('IDC')			5
DO27 N.C.	P1.10 ('IDC')			13
DO28 N.O.	P1.11 ('IDC')	Recipe Select 0	13	6
DO29 N.O.	P1.12 ('IDC')	Recipe Select 1	14	14
DO30 N.O.	P1.13 ('IDC')	Recipe Select 2	15	7
DO31 N.O.	P1.14 ('IDC')	Recipe Select 3	16	15
DO28-31 COM	P1.15 ('IDC')	Logic Gnd	12	8
DO28-31 COM	P1.16 ('IDC')			N/C
		Digital Select	10 (Jump to 11)	
		Logic Gnd	11 (Jump to 10)	

2.6. Throttle Valve Control

2.6.1. Throttle Valve Control via MKS-651

MKS-651 throttle valve controllers require an EIA-232 communications adapter to be installed on Port C of the Tymkon CPU board. In order to achieve ground isolation, comm adapter 810-0382 is used. (See page 12 for a list of available comm adapters.)

The Tymkon communicates with the MKS-651 using the MKS default communications parameters:

Baud Rate:	9,600
Parity:	None
Data Bits:	8
Stop Bits:	1

The extension cable between the Tymkon and the MKS is a 'straight-thru' modular telephone cable, DC-506P-3SV, or equivalent. The other end of the cable plugs into an adapter that consists of a 9-pin female 'D' mated to a female 6P6C RJ-12 as described below. The RJ-12/'D' adapter then plugs into a male 9-pin connector on the MKS.

Pin 1 on the RJ-12 receptacle is on the left when looking into the opening of the receptacle with the contacts across the top and the catch for the plug's latch on the bottom. Pins are labeled consecutively from left to right. Note: 'straight-thru' means that pin 1 goes to pin 1 (which looks reversed when the connectors are held end-to-end).

Note that the MKS-651 uses a proprietary pinout for its serial I/O connector. Although the MKS connector has male pins, the pinout does not match that of a standard 'DTE' device. In addition, MKS has redefined some of the pin signals such that they are incompatible with standard PC-compatible serial cables. See the following table for the pinout of the required adapter.

MKS-651 w/ EIA-232A, Isolated at Tymkon					
RJ-12 to 9-pin 'D' adapter			MKS has 9-pin male 'D'		
RJ-12 to Tymkon	Wire Color (inside adapter)	Female 9-Pin 'D' Connector To MKS-651	MKS Signal Name		
		1	N/C		
2	Yellow	2	Transmit		
3	Green	3	Receive		
		4	N/C		
1	Blue	5	Common		
		6	Reserved		
		7	Reserved		
		8	N/C		
		9	N/C		
4	Red	CTS	Cut off wire - Do not connect		
5	Black	RTS	Cut off wire - Do not connect		
6	White	Common	Cut off wire - Do not connect		

2.6.2. Throttle Valve Control via MKS-153D Integrated Valve/Controller

The MKS 153D integrated Throttle Valve/Controller has a 25-Pin female 'D' connector labeled 'J1' for power input and for RS-232 communications. Two separate cables are connected to J1: one 4-conductor cable for the power supply and one 3-conductor cable for communications as shown below:

MKS-153D w/ EIA-232A, Isolated at Tymkon					
RJ-12 to 9-pin 'D' adapter			Short Adapter Cable to 25-pin female 'D' on 153D		
RJ-12 to Tymkon	Wire Color (inside adapter)	Female 9-Pin 'D' Connector	9-pin Male 'D' on cable	25-pin Male 'D' on cable	MKS Signal Name
		1			
2	Yellow	2	2	2	TX
3	Green	3	3	3	RXD
		4			
1	Blue	5	5	7	Common
		6			
		7			
		8			
		9			
4	Red	CTS	Cut off wire - Do not connect		
5	Black	RTS	Cut off wire - Do not connect		
6	White	Common	Cut off wire - Do not connect		

To communicate with the 153D from a PC using HyperTerminal for diagnostics and configuration purposes, use settings of 9600 Baud, 8 Data Bits, NO Parity, 1 Stop Bit & CR-LF Delimiter with the following adapter cable:

9-pin Female 'D' on cable	25-pin Male 'D' on cable	MKS Signal Name
2	2	TX
3	3	RXD
5	7	Common

MKS153D Dip Switch Settings are as follows:

Dipswitch	Position	Setting
8	Closed	Pressure Controller
7	Open	Digital Set Point
6	Open	Standard RS-232 Protocol
5	Open	No Parity
4	Closed	9600 Baud
3	Closed	CR-LF Delimiter
2	Open	Set Point entry (Sxxx.x)
1	Closed	Normal Control

2.6.3. Throttle Valve Control via Millipore AC-X

Millipore (formerly Vacuum General) AC-X throttle valve controllers require an EIA-232 communications adapter to be installed on Port C of the Tymkon CPU board. In order to achieve ground isolation, comm adapter 810-0382 is used. (See page 12 for a list of available comm adapters.)

The Tymkon CPU board has a 6-pin RJ-12 female connector on Port C for connection to the serial port on a Millipore AC-X Throttle Valve controller. The extension cable between the Tymkon and the AC-X is a standard serial extension cable with a 9-pin male 'D' on the end that plugs into the AC-X and a 9-pin female 'D' on the end that plugs into an adapter that plugs into the Tymkon. The adapter consists of a 9-pin male 'D' mated to a female 6P6C RJ12 described below. A short 'straight-thru' modular telephone cable (Pan Pacific part number DC-506P-3SV, or equivalent) connects the adapter to the Tymkon.

Pin 1 on the RJ-12 receptacle is on the left when looking into the opening of the receptacle with the contacts across the top and the catch for the plug's latch on the bottom. Pins are labeled consecutively from left to right. Note: 'straight-thru' means that pin 1 goes to pin 1 (which looks reversed when the connectors are held end-to-end).

Pinout of the 6P6C RJ-12 to 9-pin male 'D' adapter is as:

RJ-12 on Tymkon	Wire Color (inside adapter)		9-Pin 'D' Connector To AC-X
		DCD from AC-X to Tymkon	1
2	Yellow	RxD from AC-X to Tymkon	2
3	Green	TxD from Tymkon to AC-X	3
		DTR from Tymkon to AC-X	4
1	Blue	Signal Common	5
		DSR from AC-X to Tymkon	6
5	Black	RTS from Tymkon to AC-X	7
4	Red	CTS from AC-X to Tymkon	8
		RI from AC-X to Tymkon	9

2.6.4. Monitoring Pressure with a Digivac Model 200 TC Gauge Monitor

Any Tymkon that does not use Port C to communicate with a Throttle Valve Controller may be configured to monitor pressure with a Digivac Model 200 TC Gauge Monitor. The Digivac reads pressure in the range of 1 milliTorr to 760 Torr and broadcasts readings through its serial port.

The Digivac require an EIA-232 communications adapter to be installed on Port C of the Tymkon CPU board. In order to achieve ground isolation, comm adapter 810-0382 is used. (See page 12 for a list of available comm adapters.)

The Tymkon CPU board has a 6-pin RJ-12 female connector on Port C for connection to the serial port on a Millipore AC-X Throttle Valve controller. The extension cable between the Tymkon and the AC-X is a standard serial extension cable with a 9-pin male 'D' on the end that plugs into the AC-X and a 9-pin female 'D' on the end that plugs into an adapter that plugs into the Tymkon. The adapter consists of a 9-pin male 'D' mated to a female 6P6C RJ12 described below. A short 'straight-thru' modular telephone cable (Pan Pacific part number DC-506P-3SV, or equivalent) connects the adapter to the Tymkon.

Pin 1 on the RJ-12 receptacle is on the left when looking into the opening of the receptacle with the contacts across the top and the catch for the plug's latch on the bottom. Pins are labeled consecutively from left to right. Note: 'straight-thru' means that pin 1 goes to pin 1 (which looks reversed when the connectors are held end-to-end).

Although most of the pins are unused, it is advisable to wire the 6P6C RJ-12 to 9-pin male 'D' adapter as follows for compatibility with other pressure monitors:

RJ-12 on Tymkon	Wire Color (inside adapter)		9-Pin 'D' Connector Digivac
		Unused	1
2	Yellow	RxD from Digivac to Tymkon	2
3	Green	Unused	3
		Unused	4
1	Blue	Signal Common	5
		Unused	6
5	Black	Unused	7
4	Red	Unused	8
		Unused	9

2.7. QuickSilver Controls Motor Port

The Tymkon CPU board has a 6-pin RJ-12 female connector for connection to the serial port on QuickSilver Controls 'E' Series motors. These motors contain an integral DSP for trajectory control and are sometimes used to load and unload wafers into horizontal furnaces.

The QuickSilver 'E' Series motors support both EIA-232 and 2-wire EIA-485 communications protocols. When the system contains only one motor, either EIA-232 or 2-wire EIA-485 may be used. However, when more than one motor is required (per Tymkon) or when Port A on the Tymkon must be shared with other devices, (remote front panel, etc), 2-wire EIA-485 must be used. On power-up, the motor automatically detects whether an EIA-232 or an EIA-485 connection has been established.

Regardless of the connection method, the Tymkon communicates with the QuickSilver motor using the QuickSilver default communications parameters:

Baud Rate:	57,600
Parity:	None
Data Bits:	8
Stop Bits:	1

The extension cable between the Tymkon and the motor is a 'straight-thru' modular telephone cable (DC-506P-3SV, or equivalent). The other end of the cable plugs into an adapter that consists of a 9-pin male 'D' mated to a female 6P6C RJ-12 as described below. The 9-pin female 'D' connector on the motor cable then plugs into the adapter.

Pin 1 on the RJ-12 receptacle is on the left when looking into the opening of the receptacle with the contacts across the top and the catch for the plug's latch on the bottom. Pins are labeled consecutively from left to right. Note: 'straight-thru' means that pin 1 goes to pin 1 (which looks reversed when the connectors are held end-to-end).

QuickSilver Controls 'E' Series Motor Connected to Tymkon w/ Model 810-0381 EIA-232 Comm Adapter				
RJ-12 to 9-pin male 'D' adapter			9-pin female 'D' on motor	
RJ-12 on Tymkon	Wire Color (inside adapter)	9-Pin male 'D' Connector to Motor		Description
1	Blue	5	5	Signal Ground
2	Yellow	2	2	RDX from Tymkon to Motor
3	Green	3	3	TDX from Motor to Tymkon
4	Red			
5	Black			
6	White			

QuickSilver Controls 'E' Series Motor Connected to Tymkon w/ Model 810-0383 EIA-422/485, 2/4 Wire Comm Adapter Configured as 2 Wire, EIA-485				
RJ-12 to 9-pin male 'D' adapter			9-pin female 'D' on motor	
RJ-12 on Tymkon	Wire Color (inside adapter)	9-Pin male 'D' Connector to Motor		Description
1	Blue	5	5	Ground
2	Yellow			
3	Green	3	3	RS485B
4	Red	2	2	RS485A
5	Black			
6	White			

Jumpers on Comm Adapter		
JP1	Receiver Phase	NOR
JP2	Half/Full Duplex	HALF
JP3	Transmitter Phase	REV
JP4	Slew Rate Limit	500k
JT1	Termination Resistor	Install Jumper

3. THEORY OF OPERATION

3.1. Tymkon Control Layers

This section details the relationship between various hardware and software control elements in process control systems comprised of a Host computer, a Tymkon™ process control engine and various electronic interface circuits and modules.

3.1.1. Background Information

Process control systems based on the Tymkon control engine contain a microprocessor-based process sequencer, various power supplies and various input/output interface circuits. In most cases, these components are housed in at least two enclosures – for example, a Tymkon Process Sequencer and a Gas Panel Interface. In some cases, however, all components are housed in a single 19-inch rack-mount enclosure, which may include both electronic and pneumatic I/O.

In most installations, the Tymkon serves as a master to additional control elements such as temperature controllers, throttle valve controllers, mass flow controllers and liquid source vaporizers. The Tymkon communicates with these devices using a multitude of connectivity protocols including proprietary asynchronous serial protocols, MODBUS, and synchronous parallel analog and digital I/O.

In installations that also include a host computer, one or more Tymkon's are 'supervised' or 'hosted' by software running on a PC. The PC provides a Graphical User Interface and a hard drive to log process variables, but, in no case is the PC responsible for real-time control or process interlocks.

3.1.2. Control and Interlock Layers

Although the following distinctions are somewhat arbitrary, it is useful to think of this type of control system as a layered structure of several hardware and software filters. At the lowest level, hardware devices such as valves and sensors are physically connected to various ports and connectors on whatever enclosure houses the interface electronics. At the highest level, the system allows the user to program combinations of virtual functions to be activated for specific amounts of time and in a particular sequence.

Between these boundaries, lay the various control and interlock layers as presented below.

3.1.2.1. Interlock Layer - Hardware

The most critical interlock functions are implemented in hardware and cannot be circumvented by user programming. These interlocks typically include criteria such as 'Don't turn on Hydrogen gas flow in a pyrogenic system unless the Oxygen is flowing' or 'Don't allow toxic gases to flow in a low pressure process unless the process door is closed'. Provisions are made on some circuit boards to configure or bypass these interlocks, but once the system is configured, the user cannot alter its behavior. This type of interlock is implemented with 'fail-safe' safe-when-energized sensor circuits and hard-wired relays.

3.1.2.2. Process Safety Layer - EPROM

The Process Safety Layer is a customized software module that is included in most Tymkon configurations where toxic or flammable gases are being controlled. This module is strategically located in the code base such that it can examine the functions about to be activated by the user's program and, if necessary, intervene.

3.1.2.3. Process Integrity Layer - EPROM

The Process Integrity Layer is another customized software module that attempts to prevent the user from programming a set of conditions that might damage the material being processed or that might damage other mechanical components of the system. This includes criteria such as 'Don't turn on Nitrogen gas unless Oxygen is flowing to prevent surface pitting' or 'Don't activate the loader on an LPCVD process unless the tube is at atmospheric pressure'.

3.1.2.4. Convenience Layer - EPROM

The Convenience Layer is a customized software module that makes the front panel displays and controls user-friendlier. This is where software resides that turns off the Boat-In-Complete and Boat-Out-Complete LED's unless the user has actually programmed a boat loader function. Another example of this type of software would be to control an autofill solenoid for a steam generator. The solenoid could be energized to fill the bubbler in response to level sensors without requiring the user to program the function.

3.1.2.5. Abstraction Layer - EPROM

The Abstraction Layer maps front panel virtual functions that the user has programmed onto various hardware ports and connectors. This layer allows the user to program a throttle valve controller that is connected to the Tymkon via an RS-232 serial port in the same manner that he programs a mass flow controller that is connected to the Tymkon with analog signals and parallel I/O.

3.1.2.6. User Layer – RAM/EEROM

At the User Layer, the software allows the user to program various combinations of functions to be energized for various amounts of time in various sequences. In addition, the software allows the normal process flow to be interrupted or modified in response to various sensors and conditions. While the behavior of all other layers is determined by circuit design or hard-coded into ROM, this layer is programmed by the end-user as Process Recipes and Segment Tables.

3.1.3. Summary

In this view of a Tymkon-based control system, the most critical parameters are monitored and controlled at the hardware level. Reconfiguring jumpers can sometimes modify the behavior of these functions, but for the most part, they are hard-wired into the interface circuitry and difficult to change without redesigning circuit boards.

The remaining control elements are implemented in software. A large percentage of the software (probably 98%) is generic. This portion of the codebase evolves as features are added, but does not get customized for each application.

The final portion of the software is customized to match the application. While a small percentage of systems are shipped with only generic code, most require some adaptation.

The software generally operates as follows:

- Read all digital sensors, analog voltages and process serial I/O.
- Map hardware input sensors and analog measurements onto front panel functions.
- Identify unsafe sensors, process interlocks and holds.
- Service all timers and identify the proper process state.
- Determine what functions the user has programmed for this process state and prepare to update hardware output devices.
- Execute the Safety Patch Layer, Process Integrity Layer and Convenience Layer and modify the output functions as required for process safety and integrity.
- Map front panel functions onto physical hardware ports and connectors.
- Execute the outputs.

3.2. Tymkon Memory Types

3.2.1. OS ROM

The *Operating System ROM* is a read-only memory device programmed by Integrated Time Systems to contain the software that controls all ***Tymkon*** operations. The system software currently resides in a 32 kilobyte ROM.

3.2.2. RAM

RAM (Random Access Memory) is the type of memory where user programs are stored in the ***Tymkon***. This type of memory is not available on newer Tymkon configurations – it has been replaced by NAVRAM (see below). Unless backup power is provided, all data is lost from *RAM* when power is removed.

3.2.3. EEROM

EEROM - This is a non-volatile read/write memory device that does not lose its information during power failures. With an *EEROM* installed, a ***Tymkon*** powers-up with the most recent user-programmed recipe information in memory. This type of memory is not available on newer Tymkon configurations – it has been replaced by NAVRAM (see below).

3.2.4. Process ROM

Process ROM - This was a read-only memory device programmed by ITS to contain recipes as specified by the process equipment manufacturer. This type of memory is not available on newer Tymkon configurations – it has been replaced by NAVRAM (see below) and Host software. ***Tymkon's*** with *Process ROM's* installed were ready to operate on power-up without additional programming, assuming that the recipes supplied by the process equipment manufacturer were still valid.

3.2.5. NAVRAM

NAVRAM is the type of memory where user programs are currently stored in the ***Tymkon***. This type of memory replaces the RAM, Process ROM and EEROM used in previous versions of the Tymkon. This unique memory architecture provides a 32-kilobyte block of non-volatile EEROM mirrored with a 32-kilobyte block of static volatile RAM. Under software control, information can be copied back and forth between the RAM and EEROM. After the user has successfully modified recipe information, either by downloading from a host or by entering data manually from the front panel, the operating system copies the recipe information from it's temporary location in RAM to it's more permanent location in EEROM.

3.3. Option Select Inputs

Some ***Tymkon*** models contain up to four (4) slide switches at the bottom of the rear panel. Three of these four switch locations are used to select software-defined options. These switches (SW1, SW2, and SW3) provide switch closures to ground and are connected to a CMOS input port through a 10,000-ohm pull-up resistor. The fourth switch (SW4) controls the NiCad battery.

SW1	In most current installations, this switch is not installed on the circuit board. The signal that goes to SW1 is also routed to the **ABORT** switch on the front panel and to the *Abort* terminal on the I/O connector.
SW2	This switch controls access to programming functions. In cabinet-mounted units, programming is disabled when this switch is UP (ON). In panel-mounted units, a panel-mounted keylock switch controls this signal. In this case, programming is enabled when the keylock switch provides a contact closure to ground. When present, the keylock switch contains a ‘double-throw’ actuator. In one position (**OPERATE**), the keylock provides a contact closure between SW2 and ground to enable programming. In the other position (**PROGRAM**), the keylock provides between SW4 and ground to enable the internal NiCad battery backup.
SW3	In most units, this switch is omitted. In some cases, it is used to enable user-selected software functions that differ between configurations. A common example uses SW3 in combination with SW2 to extend the number of *Program Enable* options available. In older installations, this switch controlled an *Interlock Hold* function. If a process input condition was unsafe and a *Branch Destination Cycle* had not been programmed, the position of this switch determined whether or not timing continued. When this switch was ON (up), timing ceased during interlock failures; when this switch was OFF, timing continued during interlock failures.
SW4	When ON (Up), this switch connects the (-) side of the NiCad battery to ground, thus enabling the backup battery. This switch disconnects the backup battery from the power supply circuit. It is important to turn this switch OFF (down) before connecting the controller to an AC power source. This permits a clean power-up response. After the unit has been connected to an AC power source, turn the switch ON (up) to enable the battery.

3.4. Power Up

Except for the Rotameter version, a 9 Volt AC external transformer furnishes all power necessary for normal operation of the Tymkon. A self-contained, rechargeable battery provides backup power, sustaining the microprocessor and memory during power interruptions. A Program/Operate switch or a slide switch disconnects the backup battery from the power supply circuit to insure a clean power-up/reset sequence when power is first applied. The battery is trickle charged as long as the battery is enabled and the unit’s transformer is connected to an AC power outlet.

During a normal power-up sequence, the operating system turns off all outputs, turns on all displays, tests all of memory (both ROM and RAM), clears all of process memory (RAM), and then retrieves recipes from the EEROM. The incoming line frequency is then checked to determine whether it is within tolerance for either 50 Hertz or 60-Hertz operation. The alarm then sounds and the alphanumeric display indicate the results of the self-test. The operating system then checks to insure that the **RUN/HOLD** switch and any remote **RUN/HOLD** switches are in the neutral position. This insures that a **RUN** sequence will not be initiated if power is applied while the unit is unattended. Next, the operating system waits for the **RESET** switch to be pressed before silencing the alarm and initializing the displays. This completes the power-up sequence.

3.5. Power Failure

During power failures with the battery enabled, the microprocessor in the ***Tymkon*** series continues to operate and remains under complete control. Unnecessary displays are turned off to reduce power consumption. In addition, the recipe-cycle-time display switches to a reduced duty cycle mode. Three different power failure situations are treated differently:

3.5.1. Power Failure during Programming

If power fails while the unit is being programmed, all outputs are de-energized and further programming is disabled until power is restored.

3.5.2. Power Failure during Standby

If power fails during the *Idle* state, all outputs are de-energized. All recipes, however, are retained in memory.

Approximately three seconds after the power failure, the alphanumeric display displays **[PWR FAIL]** and all discrete LEDs are blanked. After approximately ten seconds, the alphanumeric display is also blanked and all displays remain off until power is restored.

When power is restored, the alphanumeric display flashes **[PWR FAIL]** every other second until the next time the **RESET** switch is pressed.

3.5.3. Power Failure during Process

If a power failure occurs while a recipe is in progress, all outputs (both digital and analog) are de-energized and the temperature ramper board, if present, is powered-down. All recipes, however, are retained in memory. Approximately ten seconds after the power failure, the alphanumeric display displays **[PWR FAIL]** and all discrete LEDs are blanked. If power is restored within approximately ten seconds, the process is resumed at the point of interruption. If power remains off for more than ten seconds, the alarm sounds and the alphanumeric display flashes the recipe/cycle information at a reduced duty cycle (approximately every thirty seconds). This provides the information needed to determine the exact status of the process at the time of the power failure.

After the alarm has sounded, the operator has four options:

- Press the **ALARM** switch. - While the switch is held, the alphanumeric display will flash recipe/cycle information at an increased duty cycle to allow the operator to record the status at the time of the power fault. Pressing the ALARM switch will silence the buzzer and will still allow the operator to resume the process once power is restored.
- Press the **RESET** switch. - The alarm will silence and the alphanumeric display will be blanked. This choice resets the recipe and does not allow the operator to resume the process once power is restored.
- Press the **MODE** or the **RUN/HOLD** switch. While either switch is held, the alphanumeric display will flash recipe/cycle information at an increased duty cycle to allow the operator to record the status at the time of the power fault.

- Do nothing. - The alarm will sound until power is restored or the battery discharges. This choice also allows the operator to resume the process once power is restored.

When power is restored after an extended power failure, the alarm sounds once more. At this point, however, the alarm sounds intermittently in sync with the flashing alphanumeric display. The alphanumeric display will now alternate between **`[ Press- ]`** and **`[“Alarm”!]`**.

At this point, the operator once more has three options:

- Press the **`ALARM`** switch. - The alarm will silence and the process will resume. The display will continue to flash **`[PWR FAIL]`** every other second until the next time the **`RESET`** switch is pressed but the process will continue from the point of interruption.
- Press the **`RESET`** switch. - The alarm will silence and the ***Tymkon*** will return to *Idle*.
- Do nothing. - The alarm will continue to sound and the outputs will remain off.

3.6. Timing

Timing pulses for the ***Tymkon*** series controllers are derived from the ac power line. This avoids long-term timing errors that might otherwise arise due to crystal aging and thermal instabilities. The 50 or 60 Hz sine wave is converted to a square wave and digitally filtered to remove power-line glitches. The filtered square wave is then divided by either five or six, as determined by a software routine during power-up initialization. This technique provides a highly stable, noise-free timing pulse to the microprocessor 10 times a second, which is then further software-divided to derive actual timing intervals.

3.7. Recipes

A recipe is a listing of cycles (also known as Steps) that are to be executed in sequence. Thirty-two recipes are available, and any recipe may contain up to 64 cycles.

Cycle O of each recipe is always defined as the *Idle* (stand-by) process cycle. The last programmed cycle in each recipe is defined as the *Countup Cycle*.

During programming, a *Process Segment* or an *Auxiliary Command* is assigned to each cycle of each process recipe. Each *Process Segment* may be used any number of times in any number of recipes. This is accomplished with no need to reprogram the output/input pattern. In addition, any *Process Segment* may be selected for *Idle* and/or the *Countup Cycle*. In this manner, each process recipe may have its own unique *Standby* and/or *End-of-Recipe* conditions.

3.8. Cycles

The word *Cycle* is used to represent a step of a recipe. Generally, cycles are executed in sequence, but commands are available to alter the normal sequence. Each cycle of each recipe contains:

- either a *Process Segment* number or an *Auxiliary Command*
- a *Time* interval (0 to 999.9)
- a *TimeBase* (minutes or seconds)
- an optional *Temperature* setpoint or reference to a *Temperature Segment*

3.9. Process Segments

A *Process Segment* is a pattern of outputs-to-be-energized and an accompanying pattern of inputs-to-be-monitored. During programming, these definitions of output/input patterns are stored in a library of *Process Segments*. Any *Process Segment* may be readily retrieved from the library and assigned to a cycle of a process recipe. Memory is provided for either 32 or 64 *Process Segments*.

3.9.1. Digital Outputs

Depending on the configuration, either 16 or 32 digital outputs are available. Most units provide a relay contact closure for each digital output, while others provide NPN Darlington transistors. Software variables can invert particular digital outputs for use with Normally Open gas valves so that the user can program the output to be *ON* when they want gas to flow. See the *Installation* section of this manual on page 3 for connector pinouts.

3.9.2. Digital Inputs

Depending upon the particular ***Tymkon*** model, either eight or sixteen digital process inputs can be monitored. These inputs may be used to:

- Reduce the probability of unsafe situations,
- Alert the operator to nonstandard process conditions, or
- Suspend timing to wait for some external response.

Typical digital inputs include temperature limit switches, flow switches, door closure switches or any appropriate voltage or contact closure. On most models, an unsafe input is displayed as a continuously lighted red LED on the front panel. If an input is unsafe during a cycle in which it is programmed to be monitored, the corresponding LED flashes at the rate of five times per second.

3.9.2.1. Interlock Inputs

Selected digital inputs, often 0 through 3, are software defined to provide branching and interlock capability. Any programmed combination of interlocks which remains unsafe for longer than a 'debounce' period, (normally 3 seconds) causes an interlock failure.

Once an interlock failure has occurred, one of two responses may occur:

- If a *Branch Destination Cycle* has been programmed for the cycle in which the interlock failure occurred, the software forces a branch to the *Branch Destination Cycle* and processing resumes at that cycle.
- If a *Branch Destination Cycle* has not been programmed, the cycle remains unchanged, timing stops, outputs are forced to their *Idle* state, and an interlock alarm is sounded. The audible alarm sounds at five times per second until manually silenced regardless of whether the interlocks become safe again.

3.9.2.2. Wait-at-End-of-Cycle Inputs

Digital inputs may be software defined to provide *Wait-at-End-of-Cycle* capability. Any programmed *Wait* input or combination of such inputs causes timing to be suspended at the end of the cycle for which it is programmed. Using this technique, a cycle is lengthened until the external *Wait* input is satisfied even if the programmed time is 0.

3.9.2.3. Hold Inputs

Digital inputs may be software defined to provide *Hold-During-Cycle* capability. Any programmed *Hold* input or combination of such inputs causes timing to be suspended during the cycle for which it is programmed. Using this technique, a cycle is lengthened until the external *Hold* input is satisfied even if the programmed time is 0.

3.9.3. Analog Outputs

8-bit digital-to-analog converters drive the analog outputs on the Tymkon. Each output is programmed individually in 1% increments over the range of 0 to 99% of full scale (5.00 volts). Different setpoints may be programmed for each output in each *Process Segment*. The analog outputs are software-linked to corresponding digital outputs. That is, when a particular digital output is energized, its corresponding analog output is driven to the proper voltage level.

3.9.4. Analog Inputs

Depending on configuration, either eight or sixteen analog inputs can be monitored. These inputs are normally used in conjunction with analog outputs wherein each input is used to monitor its associated analog output. The analog inputs are used to display analog parameters (gas flow, boat speed, etc.) and to react to unsafe or undesirable process conditions. The analog inputs require no additional user programming beyond that required for analog outputs.

The analog inputs are implemented via 8-channel, 8-bit analog-to-digital converters. The converters accept voltages in the range of 0 to 5.00 volts and display them as 0 to 99%. Voltages greater than 4.95 are displayed as **`1>>`**.

The value of any of the analog inputs may be displayed on the front panel display anytime except during programming. To display an analog parameter, press the key on the front panel keypad corresponding to the analog input to be examined. The display will show the current status of that input/output pair in one of the three following formats depending on the software configuration:

- **`[Aaa/Tbb%]`**, where **`bb`** is the current programmed value of the analog output and **`aa`** is the measured value of the analog input (both displayed as a percentage of 5.00 volts).
- **`[K aa/bb%]`**, where **`bb`** is the current programmed value of the analog output and **`aa`** is the measured value of the analog input (both displayed as a percentage of 5.00 volts).
- **`[K aaa/bb]`**, where **`bb`** is the current programmed value of the analog output and **`aaa`** is the measured value of the analog input displayed to 0.1% resolution (both displayed as a percentage of 5.00 volts).

The ***Tymkon*** continuously monitors all analog inputs and automatically reacts to unsafe or undesirable conditions. Each analog input can be software defined to react to one of three possible undesirable conditions:

- Guard Band -- An analog input can be compared to its programmed output value, and declare an alarm (after the debounce time) if the input differs from the output by more than a predefined guard band.
- Upper Limit -- An analog input can be compared to its programmed output value, and declare an alarm (after the debounce time) if the input is greater than its programmed output.

- Lower limit -- An analog input can be compared to its programmed output value, and declare an alarm (after the debounce time) if the input is less than its programmed output.

Each analog input can be defined to act as an *Interlock* input, an *Alarm* input, a *Wait-at-End-of-Cycle* input, a *Hold-During-Cycle* or as some combination of these (see previous section on digital *Interlock*, *Wait* and *Hold* inputs). As soon as an out-of-range condition is sensed on an analog input, the front panel LED for the corresponding output begins to flash. This happens whenever an analog output is energized whether in standby or while running a recipe. This flashing continues as long as that analog output is determined to be out-of-range.

There is a separate debounce timer (normally set to 30 seconds) for each analog input. If the analog input has been defined to be an *Interlock* input and the input has remained out-of-range longer than the debounce time, the analog interlock sounds the alarm, as a digital interlock would, and a branch occurs if it has been programmed. If the analog input is defined to be a *Wait* input, timing is suspended at the end of the cycle until the input becomes safe as with a digital *Wait* input.

If the analog input debounce time expires on an out-of-range *Alarm* analog input, the alarm sounds regardless of whether a *Wait* or *Interlock* is defined for that input.

3.10. Auxiliary Commands

Auxiliary Commands are a group of ***Tymkon*** software instructions that may be inserted into cycles of recipes in place of the usual *Process Segments*.

Cycles that contain an *Auxiliary Command* do not reference a *Process Segment* and do not have a programmed duration; they execute instantaneously. All of the existing *Auxiliary Commands* require either one parameter or no parameters. For those *Auxiliary Commands* that require a single parameter (example: '*Branch to Recipe 2*'), that parameter is accessed in *Mode 2* using the *Enter* key to toggle between the command and its parameter.

Some future *Auxiliary Commands* may require two parameters (example: '*Loop to Cycle 6, 10 times*'). The second parameter to those commands will be accessed in *Mode 3* just at time intervals are accessed. Those commands that do not require a second parameter are skipped over when stepping through cycles in *Mode 3*.

Since none of the *Auxiliary Commands* apply to the *Idle* state, the operating system prohibits the user from entering an *Auxiliary Command* in *Cycle 0*. In addition, the user should avoid programming an *Auxiliary Command* as the last cycle of a recipe. When the software encounters an *Auxiliary Command* as the last cycle of a recipe, a reset is asserted and the ***Tymkon*** returns to the *Idle* state. Under these conditions, the *End-Of-Recipe* alarm will not sound.

Following is a summary of *Auxiliary Commands*:

Cmd	Function	Branch Operand	Time Operand
64	Null Process Segment	NA	NA
73	Holdback Mode	Deviation Setpoint (Degrees)	NA
74	Max Wait Time	0 to 99 Minutes	NA
84	Programmable Alarm	NA	NA
85	Programmable Alarm Silence	NA	NA
86	Programmable Hold	NA	NA
87	Programmable Abort	NA	NA
88	Programmable Reset	NA	NA
95	Clear Latched Inputs	NA	NA
97	Recipe Branch & Idle	Branch Destination Recipe	NA
98	Recipe Branch & Run	Branch Destination Recipe	NA
99	Unconditional Branch/Loop	Branch Destination Cycle	(Loop Count not yet implemented)

3.10.1. Cmd 64 – Null Process Segment

This command has no effect. It may be used as a placeholder or to eliminate a specific process cycle while maintaining existing cycle numbers. No operands are required for this command.

3.10.2. Cmd 73 – Holdback Mode

This command is used in conjunction with Eurotherm Temperature Controllers to insure furnace temperature flat zone uniformity during temperature ramping. While in Holdback Mode, the setpoints to the faster ramping zones are restricted to prevent those zones from deviating beyond a user-programmed value from the slower ramping zones. The Holdback command accepts an argument ranging from 0 to 99. A Holdback argument of '0' terminates Holdback Mode while an argument ranging from 1 to 99 sets the Holdback guard band in degrees.

3.10.2.1. Holdback Duration

The Holdback command may not be used in Cycle 0 or in the count-up cycle at the end of the recipe. Holdback Mode takes effect at the cycle following the cycle containing the Holdback command and terminates at the end of the Recipe or when a Holdback command with an argument of 0 is encountered.

3.10.2.2. Holdback Conditions

Holdbacks will only take effect during cycles where:

- The final temperature is different from the beginning temperature,
- All furnace zones have the same beginning setpoint temperature and
- All furnace zones have the same final setpoint temperature.

3.10.2.3. Holdback Behavior

Holdback first determines whether a ramp up or a ramp down has been programmed.

Holdback then compares the actual temperature values reported from the Eurotherm controllers. During ramp up, the zone (or zones) with the lowest actual temperature is identified. During ramp down, the zone (or zones) with the highest actual temperature is identified.

The zones with the lowest temperature during ramp up, or the highest temperature during ramp down, are sent the setpoints that were calculated by the ramp module.

The zones with temperatures greater than a user-programmed value higher than the lowest temperature during ramp up, or the zones with temperatures lower than the user-programmed value less than the highest temperature during ramp down, are sent modified setpoints to slow their ascent/descent rate.

3.10.3. Cmd 74 – Max Wait Time

While the Tymkon is in a cycle in which one or more Wait inputs are monitored, a 'Wait' timer is triggered after the programmed cycle time has elapsed. In some cases, it is desirable to trigger an audible alarm when the wait time becomes excessive. The 'Max Wait Time' setpoint allows the user to set the time interval after which an alarm will sound. The setpoint may range from '0' to '99' minutes where a setting of '0' disables the audible alarm. The 'Max Wait Time' set with this command stays in effect for the duration of the recipe unless another 'Max Wait Time' command is encountered.

3.10.4. Cmd 84 - Programmable Alarm

This command causes an alarm function similar to the *Programmable Cycle Alarm*. The *Auxiliary Command* version is added for consistency. No operands are required for this command.

3.10.5. Cmd 85 - Programmable Alarm Silence

This command silences any pending alarms as though the **ALARM** button on the front panel had been pressed. No operands are required for this command.

3.10.6. Cmd 86 - Programmable Hold

The *Programmable Hold* causes an unconditional hold at any point in a recipe. No operands are required for this command. When the software encounters a *Programmable Hold*, a hold state is activated and the cycle pointer is incremented to the next cycle. Any additional *Auxiliary Commands* that are encountered before the next process cycle will be executed before the hold state is activated.

3.10.7. Cmd 87 - Programmable Abort

This command causes an instantaneous abort to occur at any point in a recipe. No operands are required for this command. When the software encounters a *Programmable Abort*, the abort state is activated just as though the **ABORT** switch on the front panel had been pressed. In addition, the cycle pointer is incremented to the next cycle. Any additional *Auxiliary Commands* that are encountered before the next timed cycle will be executed before the abort state is activated

3.10.8. Cmd 88 - Programmable Reset

This command causes a reset to occur at any point in a recipe. This provides a way to bypass the normal *Countup Cycle* at the end of a recipe by forcing the ***Tymkon*** to *Cycle 0*. No operands are required for this command.

3.10.9. Cmd 95 - Clear Latched Inputs

This command clears any digital inputs that might have been latched unsafe. No operands are required for this command.

3.10.10. Cmd 97 - Recipe Branch & Idle

This command causes an instantaneous branch to *Cycle 0* (*Idle*) of a different recipe. After the branch occurs, the *Reset* function is asserted to terminate timing and silence alarms. The number of the *Branch Destination Recipe* can be programmed in *Mode 2* in place of a *Branch Destination Cycle*.

3.10.11. Cmd 98 - Recipe Branch & Run

This command causes an instantaneous branch to *Cycle 1* of a different recipe. After the branch occurs, *Cycle 1* and any successive cycles are timed as though the recipe had been selected and run from the front panel. The number of the *Branch Destination Recipe* can be programmed in *Mode 2* in place of a *Branch Destination Cycle*.

3.10.12. Cmd 99 - Unconditional Branch/Loop

The *Unconditional Branch/Loop* command causes a branch <u>from</u> any cycle of a recipe (except *Cycle 0*) <u>to</u> any cycle of the same recipe (except *Cycle 0*). When the software encounters an *Unconditional Branch/Loop*, the cycle pointer is changed to point to the cycle programmed as the branch cycle. If a *Branch Destination Cycle* has not been programmed, or if the branch cycle is 0, or if the *Branch Destination Cycle* equals the current cycle, the ***Tymkon*** branches to the *Countup Cycle* at the end of the recipe. At a particular cycle, after the number of branches as specified in the *Loop Count* has occurred, the *Unconditional Branch/Loop* instruction is ignored and the process continues at the next sequential cycle. This permits the user to program an infinite variety of multiple counted and timed loops. If the user programs a condition that causes an inescapable tight loop (such as repeated branching between cycles that have 0 times), the ***Tymkon*** branches to *Cycle 0* and resets.

3.11. Usage Timers

The Tymkon operating system maintains integrating usage timers for each of its digital and analog inputs and outputs. These timers are not accessible from the Tymkon front panel and may only be accessed using PC-based host software such as *TymPlex* from Integrated Time Systems. In the case of analog inputs such as gas flows, the timers integrate the product of the actual gas flow and the amount of time the gas been flowing. For example, if a gas channel with a 10 LPM Mass Flow Controller were allowed to flow at 50% for 100 minutes in one cycle and then at 25% for 40 minutes in another cycle, the usage timer would display a value of 60 minutes. Multiplying 60 minutes times 10 LPM determines that 600 Liters of that particular gas has flowed.

3.12. Manual Mode

Most ***Tymkon's*** are available with a *Manual Mode* of operation. This mode is convenient for maintenance use in that it permits easy activation of output functions without having to understand all of the programming details and features.

The *Manual Mode* makes use of a particular *Process Segment*, usually *Segment 62*, as a scratch pad for energizing output functions. If required, inputs may also be monitored in this mode using the normal *Mode 1* programming procedures.

Alert! Be aware that on rare occasions, either the end user or the manufacturer of the equipment being controlled has requested that safety checks included in Custom Software Modules be disabled during Manual Mode.

3.13. Time-This-Cycle Display

Each of the cycles in a recipe (except *Cycle O* and the *Countup Cycle*) can be assigned a time from 0 to 999.9 minutes or 0 to 999.9 seconds. During the timed cycles, a four-digit front panel display indicates the time remaining in the current cycle. During *End-of-Recipe*, this same display indicates the elapsed time since completion of the process (count-up time).

3.14. Runs Counter Display

Runs Counters tabulate and display the number of runs processed by each of the recipes. Each counter can count to 999 runs and is cleared individually. The *Runs Counters* are incremented only on natural transitions to the *Countup Cycle*; that is, if an operator manually steps through a recipe to check gas flows or other process conditions, the *Runs Counter* is not incremented.

The contents of the *Runs Counter* for the currently selected recipe are displayed continuously during the *Idle* state. The format of the display is "**xxxR**" where "**xxx**" is the number of completed runs for the current recipe. If more than 999 runs have been completed, the display indicates "**999R**".

Since Recipe 0 is reserved for *Manual Mode*, Recipe 0 does not require a separate counter. Therefore, the *Runs Counter* for Recipe 0 is used to accumulate the total number of runs processed in all recipes. This special counter is incremented each time any recipe is completed.

3.15. Total-Time-Remaining Display

A six-digit front panel display indicates the total time remaining in a recipe. This display is disabled during programming and during the *Idle* state. The format of the display is **HH MM SS**. When the total time remaining in a process exceeds 99:59:59, a display overflow condition exists and is displayed as **"-- -- --"**. This overflow has no effect on actual execution of the process, and the display automatically reverts to its normal format when the overflow no longer exists. During *End-of-Recipe*, the *Total-Time-Remaining* display flashes **"00 00 00"** at the rate of five times per second.

3.16. Custom Software Modules

In many cases, the ***Tymkon*** operating system is enhanced by the addition of custom safety interlocks. Especially in OEM applications where inputs and outputs are assigned before installation, a routine may be provided which prohibits the user from energizing unsafe combinations of digital outputs and/or analog set-points.

Examples of typical *Custom Software Modules* include:
- Adjusting H_2 analog setpoint based on actual O_2 flow to avoid excessive H_2 in burnt-Hydrogen systems,
- Shuffling digital outputs or inputs to match pre-existing front panel layouts, or
- Pulsing digital outputs to provide physical agitation of a pneumatic cylinder.

3.17. Manual Abort

In addition to the programmed branching capability, an **ABORT** switch is provided to permit a forced branch to user-defined conditions. This switch is monitored during timed cycles and provides a way for the operator to force the process to a known safe condition. When the **ABORT** switch is pressed, the outputs currently programmed for *Process Segment 63* are energized, and appropriate alarms are displayed. Processing may be resumed by pressing the **RUN/HOLD** switch momentarily to put the ***Tymkon*** in the **HOLD** state and then pressing the **RUN/HOLD** switch again to put the ***Tymkon*** in the **RUN** state.

3.18. Alarms

The audible and visual alarm system permits rapid identification of a process requiring attention. There are four basic alarm formats:
- Self-canceling,
- Once per second,
- Five times per second, and
- Continuous.

A tabulation of alarm conditions and their corresponding alarm patterns follows:

3.18.1. Hold

If the **RUN/HOLD** switch is changed from the **RUN** to the **HOLD** position during any timed process cycle, a self-canceling alarm sounds for 1.6 seconds.

3.18.2. End-of-Recipe

At the beginning of the *Countup Cycle*, an alarm sounds once per second. Simultaneously, the *Total-Time-Remaining* display flashes **"00 00 00"** five times per second. The audible alarm can be silenced with the **ALARM** switch, but the visual indication continues until the **RESET** switch is pressed.

3.18.3. Interlock Failure (during process)

An unsafe interlock that is programmed to be monitored is indicated by an LED flashing five times per second. If the interlock remains unsafe for more than the debounce interval (normally 3.2 seconds), an audible alarm sounds along with the visual indication. The audible alarm may be silenced with the **ALARM** switch, but the visual indication continues as long as the monitored input is unsafe.

3.18.4. Interlock Alarm (during End-of-Recipe)

Simultaneous occurrence of an interlock failure and *End-of-Recipe* results in a combined alarm. The alarm sounds five times per second, as during any interlock failure, but is interrupted once each second to indicate *End-of-Recipe*.

3.18.5. Power-Up Alarm

After a normal power-up sequence, the alarm sounds continuously until the **RESET** or the **ALARM** switch is pressed.

3.18.6. Power-Fail Alarm

Whenever power fails during operation, the alarm sounds until power is restored or the **ALARM** switch is pressed.

3.18.7. Programmable Alarm

Programmable alarms may be assigned to any combination of process segments and recipe cycles. When a programmable alarm is encountered, the alarm sounds continuously until the **ALARM** or **RESET** switch is pressed. A [**PROG ALM]** message on the alphanumeric display accompanies the alarm.

3.19. End-of-Recipe Log

The *End-Of-Recipe* state on the ***Tymkon*** begins when all of the timed cycles of a recipe have timed out. This is indicated by an audible alarm (one pulse per second) and a visual **[COMPLETE]** message on the alphanumeric display. The state terminates when the recipe is reset back to the *Idle* cycle.

The *End-Of-Recipe Log* stores up to 64 entries. Each entry contains information concerning the conditions under which the corresponding recipe was terminated. When more than 64 recipes have been processed, the software automatically displaces the oldest entry with the most recent data.

The *End-Of-Recipe Log* is accessed using *Mode A*. While in *Mode A*, the **STEP** key steps through all entries from the most recent to the oldest. The **CLEAR** key, if programming is enabled, erases the entire table.

While in *Mode A*, two different messages share the alphanumeric display. One message is displayed during the first second of each two-second interval; the other message is displayed during the last second of each two-second interval.

While any key is pressed and during the first second of each two-second interval, the message **[RUN -##]** is displayed. In the actual message, the **##** represents an entry number in the range of **01** (the most recent recipe) through **64** (the oldest).

During the last second of each two-second interval, one of the following messages appear:

[DATA END] -- this indicates that no additional entries have been logged.

[r ABORT] -- the **r** in this message represents the recipe that was processed when the entry was recorded, while the **ABORT** indicates that the recipe was terminated before the recipe was complete.

[r >999'] -- the **r** in this message represents the number of the recipe that was being processed when the entry was recorded. The **>999'** indicates that the ***Tymkon*** was not reset within 999.9 minutes.

[r mmm.m'] -- the **r** in this message represents the number of the recipe that was being processed when the entry was recorded. The **mmm.m** indicates the amount of time before the ***Tymkon*** was reset. (This assumes that the time interval was greater than 0.1 minutes or 6 seconds.)

[r   s.s"] -- the **r** the in this message represents the number of the recipe that was being processed when the entry was recorded. The **s.s"** indicates the amount of time before the ***Tymkon*** was reset. (This assumes that the time interval was less than 0.1 minutes or 6 seconds.)

3.20. Event Log

When present, the *Event Log* option stores up to 15 entries.

This module records unusual events that occur while a recipe is being processed. The table of logged events is automatically cleared when a new recipe is initiated. If the event table ever becomes filled within a recipe, the log function ceases to record events.

For purposes of the *Event Log*, the following conditions are considered to be unusual events:

- Branches caused by an interlock failure.
- Front panel *Abort* switch being pressed.
- Entering *Hold* mode during the recipe.
- *Reset* before completion of recipe.

While in *Mode B*, several different message formats share the alphanumeric display:

[LOG END]-- This message is displayed when no additional entries have been logged.

[LOG FULL]-- This message is displayed when the event table is filled to capacity.

[#ee XXXX]-- This message is displayed while any key is pressed and during the first second of each two-second interval. In the actual message, **ee** represents the number of the event currently being displayed and **XXXX** is replaced with:

- **BRCH (**interlock branch occurred),
- **ABRT** (*Manual Abort* was pressed),
- **HOLD** (*Hold* mode was entered) or
- **RSET** (recipe was *Reset* before completion).

[rccbtttt]-- This message is displayed during the last second of each two-second interval. In this message, **r** represents the recipe being processed when the event occurred, **cc**

represents the cycle number, **b** represents the time base in effect (**'** for minutes or **"** for seconds), and **tttt** represents the elapsed time when the event occurred.

3.21. Host Communications

Details of the Tymkon-Host communications protocol are available in a separate document. An extensive set of commands and queries is available to program, control and datalog all Tymkon functions from a host PC.

3.22. Throttle Valve Control

In many applications, the Tymkon communicates with a throttle valve controller via an EIA-232 interface (Tymkon Comm Port C). The communications parameters are set to the throttle valve controller's default settings: baud=9600, parity=none, stop bit=1 and data bits=8. When the AC-X controller is used, the message delimiter is LF and when the MKS-651 is used, the message delimiter is CRLF.

The user programs the throttle valve using a pre-assigned output function referred to as Throttle Enable on the Tymkon front panel. During programming, Throttle Enable has both an ON/OFF function and an analog setpoint. The analog value programmed is the desired pressure setpoint. Whether a 1 Torr transducer or a 10 Torr transducer is used, the setpoint is expressed as a percentage of 1 Torr. Thus a setpoint of 1% would cause the throttle valve controller to control at 0.010 Torr or 10 milliTorr. Similarly, a setpoint of 25% would cause the throttle valve controller to control at 0.250 Torr or 250 milliTorr.

In addition to the Throttle Enable function, some installations include a Throttle Position function. This function provides an analog channel for sending throttle position back to the host computer for datalog and maintenance purposes.

Another optional feature allows selected configurations to take advantage of the five distinct Setpoint/PID combinations available on some throttle controllers. When the user programs a setpoint selection value ranging from 1 through 5 on a Tymkon output function (usually sharing the same output function that displays 'TTL Position'), the Tymkon sends the setpoint value that was programmed on the Throttle Enable function to the selected setpoint as programmed on the Throttle Position function setpoint. The Tymkon then commands the throttle controller to switch to that setpoint.

Another option is a Throttle Open function. This function provides an alternate means of forcing the throttle valve open. This option is not included unless there is a need to use modes 0 or 4 as shown in the table below.

The Tymkon software supports five throttle valve control modes as listed below. Only Modes 1 & 3 are used in most installations:

Throttle Enable Fn	Throttle Open Fn	TTL Mode	Action
OFF	OFF	0	Close Valve
OFF	ON	1	Open Valve
OFF	ON	2	Open Valve and zero Base Pressure
ON	OFF	3	Throttle at xx.x% of full scale
ON	ON	4	Hold valve position

- TTL Mode 0: The Tymkon is sometimes configured to send a "CLOSE" command to the throttle valve controller forcing the throttle valve to its fully closed position under some conditions (such as when the Door is Open or the Pump is off). This mode is not implimented in most horizontal furnace applications.
- TTL Mode 1: The Tymkon sends an "OPEN" command to the throttle valve controller forcing the throttle valve to its fully open position. This occurs when the TTL Enable output is OFF and when the TTL Open (if present) is ON.
- TTL Mode 2: The Tymkon sends an "OPEN" command to the throttle valve controller forcing the throttle valve to its fully open position. In addition, when special conditions are met, the Tymkon tells the throttle valve controller to zero its base pressure reading. This mode is not implimented in most horizontal furnace applications.
- TTL Mode 3: The Tymkon sends a setpoint to Setpoint Register 1 in the throttle valve controller and commands the valve to throttle at Setpoint 1.
- TTL Mode 4: The Tymkon commands the throttle valve controller to hold it's current valve angle. This mode is not implimented in most horizontal furnace applications.

In each of the five possible throttle modes, the Tymkon Throttle Communications software steps through a sequence of four command or query messages as detailed in the table below. Each message is allowed two seconds to complete. Thus, a complete sequence completes once every eight seconds. Note that the <CRLF> message terminator differs depending on the type of throttle controller in use as stated above.

TTL Mode	1st Command	2nd Command	3rd Command	4th Command
0 (Close)	C<CRLF>	R5<CRLF>	R6<CRLF>	R5<CRLF>
1 (Open)	O<CRLF>	R5<CRLF>	R6<CRLF>	R5<CRLF>
2 (Zero)	O<CRLF>	A0<CRLF>	R5<CRLF>	R6<CRLF>
3 (Throttle)	S1xx.x<CRLF>	D1<CRLF>	R5<CRLF>	R6<CRLF>
4 (Hold)	H<CRLF>	R5<CRLF>	R6<CRLF>	R5<CRLF>

In addition to the serial data connection, the Limit Switches on the MKS-651 are usually connected to Tymkon digital inputs by way of a Gas Panel Interface. The MKS-651 includes two Process Limit Switches; Process Limit 1 is used as a 'Leak' input and Process Limit 2 is used as an 'Over Pressure' input. After installation, perform the following steps to configure the MKS-651:

- Program the MKS-651 for the proper Baratron range
- Set Process Limit 1 Low to -10 Torr (or whatever the maximum range is)
- Set Process Limit 1 High to the desired LEAK Limit
- Set Process Limit 2 Low to -10 Torr (or whatever the maximum range is)
- Set Process Limit 2 High to the desired OP Limit

3.23. Temperature Ramping

The ***Tymkon*** Process Sequence Controller is especially well suited to control the multiple gas streams, vacuum pumps and boat loaders required for accurate and repeatable semiconductor furnace processing. The most difficult process parameter to synchronize with the gas flows and boat loaders has always been the temperature of the diffusion furnace itself. As wafer diameters continue to increase, more and more furnace operations rely on temperature ramping between cycles to reduce warpage and/or improve gettering.

Many DDC[1] systems address this problem by incorporating closed loop furnace temperature control into the gas control system, while less expensive gas sequencers rely on external bi-level ramp controllers to alter furnace temperature.

The ***Tymkon*** Process Sequence Controller, however, performs temperature setpoint ramping by sending remote setpoints to stand-alone, closed-loop temperature controllers similar to the manner in which gas control is achieved by sending remote setpoints to stand-alone, closed-loop Mass Flow Controllers.

In applications where the ***Tymkon*** is used to control temperature setpoints, as well as gas flows, several alternatives are available:

- A 16-bit analog output board, or
- An EIA-422 interface for one or more Eurotherm controllers, or
- An EIA-485 interface for Watlow/Anafaze controllers, or
- A 4-bit binary output for DTC temperature controllers.

In all installations, the ***Tymkon*** provides a remote setpoint command to the existing temperature controller that continues to perform the closed-loop temperature control function.

The 16-bit analog board is best suited for retrofit applications where the original temperature controller will be retained. The EIA-485 option is best suited for new installations and for retrofit applications where the temperature controllers are being updated or replaced.

With either approach, the output can be programmed to cause the furnace temperature to ramp linearly between many different setpoints during a process. During recipe selection, a timer prevents the ramper output from changing during the first 10 seconds of *Cycle 0* of the new recipe. This prevents random changes in temperature during recipe 'hopping'.

3.23.1. Multizone Ramping

Current ***Tymkon*** versions are able to supervise up to eight temperature control loops. This capability can be applied to installations containing multiple Eurotherm controllers multidropped together in an EIA-422 network or to installations containing a single Watlow/Anafaze PPC controller an a MODBUS connection.

Tymkon's multizone ramping software permits each of the eight channels to be individually configured to behave as a ramped furnace zone or as a non-ramped external torch or liquid source zone. Several other parameters allow individual zones to be monitored for temperature deviation or datalogged.

[1]DDC: Direct Digital Control system - Computer-controlled system which sequences gas valves, furnace temperature, boat loaders etc. in response to time-based recipes and external sensors.

The ***Tymkon*** recipe editor, ***TymEdit***, allows the user to program different setpoints for each zone of the furnace at any point in the recipe, thereby permitting use of sloped, ramped temperature profiles.

3.23.2. Temperature Interlocks

In applications in which the ***Tymkon*** communicates with one or more temperature controllers over a serial port (e.g. Eurotherm Model 808/847/2216/2408), the ***Tymkon*** may be configured to monitor the temperature controller to insure that the actual furnace temperature is within acceptable limits.

In this type of installation, the ***Tymkon*** queries the temperature controller for the actual furnace temperature over the serial port every two seconds. If the temperature controller sends back an appropriate response, the temperature interlock is satisfied. If the temperature controller does not respond, or if the response is not within the acceptable guard band, the ***Tymkon*** declares a temperature fault. After three successive temperature faults, The ***Tymkon*** lights one of the digital input LED's (as selected during system configuration) and declares an input failure. The user may program additional response to the temperature fault as though it were a typical digital input.

Timing - Since this watchdog function occurs every ten seconds and since three successive faults must occur before an interlock failure is declared, the ***Tymkon*** will respond to a temperature problem within 39.9 seconds, but not before 30.0 seconds. When the temperature returns to acceptable limits, the interlock will be cleared within 9.9 seconds.

Guard Band - The ***Tymkon*** makes a distinction between two different conditions to determine an acceptable temperature guard band. When the ***Tymkon*** is in a cycle is which the temperature **is not** being ramped, a narrow guard band is used (±10 degrees Celsius unless a different value is requested by the user). When the ***Tymkon*** is in a cycle is which the temperature **is** being ramped, a wider guard band is used (typically ±50 degrees Celsius unless a different value is requested by the user).

3.23.3. Temperature Control using Thermocouple Offset

The 16-bit analog ramper board generates a very accurate voltage in the range of -9.999 volts to +9.999 volts. The circuitry is optically and transformer isolated from the digital control circuitry and from the standard 8-bit analog outputs. Therefore, a high degree of flexibility is achieved as to installation of the ramper. Temperature controllers that provide for an external analog setpoint can use this signal as a remote temperature setpoint.

Alternately, the 16-bit analog board may be jumpered to generate a voltage in the range of -9.999 millivolts to +9.999 millivolts. This signal can be connected in series with the control thermocouple on nearly any thermocouple type temperature controller. In this type of installation, the ***Tymkon*** generates an offset voltage that algebraically adds to the voltage generated by the center zone control thermocouple. Thus, the temperature controller is faked into controlling at various setpoints.

Both of these analog configurations suffer minor disadvantages. One is that the user must program the ***Tymkon*** in units other than degrees (e.g., volts or millivolts). Next, when the thermocouple-offset approach is used, the user must program an offset value rather than an absolute setpoint. Lastly, accuracy requires that both the temperature controller and the ***Tymkon*** analog board be properly calibrated and that the wiring be properly installed.

None of these disadvantages are present in installations where the ***Tymkon*** is permitted to communicate with the temperature controller over a digital interface such as EIA-232. In this type of application, the ***Tymkon*** sends temperature setpoints to the temperature controller as actual values in degrees Celsius in ASCII format. There are no calibration errors, no unit conversion errors and no ground loop problems.

3.23.4. Temperature Control with Eurotherm Model 808/847/2208/2216/2408

Tymkon process sequence controllers manufactured after Y2000 can be configured to exchange data with one Eurotherm temperature controller using EIA-232 or up to eight controllers using a 4-wire, EIA-422 multi-drop connection. The Eurotherm controllers supported include Models 808, 814, 2216 & 2408. No Eurotherm ramping or programming options are required for proper operation. (Note that the features differ between models with the Model 2408 having the most comprehensive feature list.)

Programming the ***Tymkon*** temperature setpoints is accomplished using the recipe editor (TymEdit), or from the front panel via *Mode 4*. The desired process temperature endpoints are entered in degrees Celsius and the ***Tymkon*** software calculates ramped setpoints for up to eight zones throughout the duration of each process cycle.

When dual-input Eurotherm's are used with the ***Tymkon***, Mode 4 behaves generally as described elsewhere in this manual. One significant difference is that the ENTER key is used to toggle the temperature setpoint between "S" (spike T/C) mode and "P" (Process T/C) mode.

3.23.4.1. Temperature Control Capabilities

The ***Tymkon*** recipe editor (TymEdit), the host software (TymPlex) and the ***Tymkon***'s embedded firmware are designed to support ramped temperature setpoints for all eight channels as well as up to two thermocouple inputs for each channel. In addition, the user may select on a cycle-by-cycle basis which of the thermocouple inputs is used as the control thermocouple. Typically, in these applications, Input 1 is used as the Spike thermocouple and Input 2 is used as the Process (or Profile) thermocouple.

In a typical horizontal diffusion furnace application, three channels may be used to control the three furnace heating zones and additional channels may control or monitor an external H2 torch, one or more liquid source heaters and, possibly the furnace cabinet temperature or vacuum pump temperature.

Similarly, in a vertical diffusion furnace application, five channels may be used to control the five furnace heating zones and the remaining three channels may control or monitor other peripherals.

Information provided in the remainder of this section is more detailed and more technical than the average user requires.

3.23.4.2. Temperature Control Parameters

In order to accommodate the variations in temperature controllers and the requirements of the application, several parameters are provided in the Tymkon software to customize its behavior. These parameters are assigned values appropriate to the application and become part of the ***Tymkon***'s operating system.

RMPMASK1
This 8-bit value determines which of the 8 channels have temperature setpoints. This value allows the software to skip channels that are unused or used only to read thermocouple data.

RMPMASK2
This 8-bit value determines which of the 8 zones accept temperature setpoints from cycle data. That is, when the user assigns a temperature to a cycle (e.g. in Mode 4), it will be sent to the furnace zones specified in this mask, but not to an external torch or liquid source controller. Setpoints for the remaining channels must be specified in the Temperature Segment Table.

RMPMASK3
This 8-bit value determines which of the 8 zones are ramped. Any zone not specified here makes instantaneous temperature setpoint transitions.

RMPMASK4
This 8-bit value determines which ONE of the 8 zones is monitored by the ***Tymkon*** for temperature deviation. At present, only one channel can be monitored. Other variables determine the allowable guard-band for setpoints that are ramped (TMP_LIM1 typically 25 or 50 degrees) and for setpoints that are not ramped (TMP_LIM0 typically 5 or 10 degrees). In addition, a variable named TMP_ILK specifies which, if any, digital input is used to display 'Temperature Fault' on the ***Tymkon*** front panel.

RMPMASK5
This 8-bit value determines which ONE of the 8 zones is reported to the host as part of the SIMPLE STATUS message. This single channel is displayed on the ***Tymkon*** screen that contains the RUN/RESET controls whereas all eight channels are displayed on the less convenient GRAPH screen.

RMPMASK6
This 8-bit value determines which of the 8 zones is capable of Spike/Process thermocouple selection.

RMPMASK7
This 8-bit value determines which of the 8 zones supports negative Mode 4 values. This parameter is used only with analog output temperature setpoint channels, not with Eurotherm temperature controllers.

RMPSETUP
This label refers to a ROM-based table that controls communications with the individual Eurotherm PID controllers. It specifies the Device ID for each controller and which messages (setpoint message, present value query, etc) are to be sent to each controller. For example, in Master/Slave configurations, the end zones might be sent query messages but not setpoint messages.

3.23.4.3. Eurotherm Communications Driver

The messages exchanged between the ***Tymkon*** and the Eurotherm controllers differ slightly depending on whether the temperature controller supports dual inputs (Model 2408 does, Model 808 and Model 814 do not).

A message-sequencer module in the ***Tymkon*** ROM manages Tymkon-to-Eurotherm communications. The message-sequencer allocates a 2-second time slot to each temperature controller. In a typical three or four-temperature controller installation, one or two unused time slots are inserted such that each controller gets updated once each 10 seconds.

During the 2-second time slot that each controller is assigned, up to eight messages may be exchanged between the ***Tymkon*** and the controller. Some of those messages are commands that the ***Tymkon*** sends to the Eurotherm while others are queries wherein the ***Tymkon*** requests data from the Eurotherm.

Communication between the ***Tymkon*** and the temperature controllers is disabled while the ***Tymkon*** is in any programming mode and, when the ***Tymkon*** is in *Manual Mode*. Disabling communications during ***Tymkon*** programming prevents incomplete data from being sent to the temperature controllers. Disabling communications when the ***Tymkon*** is in *Manual Mode* provides the user a way to work with the temperature controller in its manual mode without having the ***Tymkon*** override manual control.

Some of the programmable parameters on Eurotherms are not accessible to the ***Tymkon*** over the communications link. These parameters have the proper values when the controllers are shipped from Eurotherm and must not be altered by the user. For example,

- Communications Baud Rate: 9600
- Control Type: PID

In some applications, it may be desirable for the installer to 'HIDE' these parameters from the user using the procedures described in the Eurotherm manual.

Many of the remaining Eurotherm control parameters (for example: thermocouple type, proportional band, output configuration, device address etc.) are not altered by the ***Tymkon***. It is the responsibility of the installer or the user to make appropriate adjustments to these parameters, if necessary.

The following table details the Eurotherm messages that have been implemented in the Tymkon software. The messages are listed in the order they occur in the communications stream, but not all messages are used with all Eurotherm models.

Msg	Command	Type	Function
1	pv0 pv1	Command Command	Selects T/C 1 as control value Selects T/C 2 as control value
2	Gn0 Gn1	Command Command	Selects PID Table 1 Selects PID Table 2
3	SS0 SS1	Command Command	Selects Setpoint 1 Selects Setpoint 2
4	SLzzzz	Command	Sends setpoint to SP1 or SP2
5			
6	PV	Query	Query PV of selected input
7	QY	Query	Query PV of Input 1
8	QZ	Query	Query PV of Input 2

pv0/pv1
This command determines which of two inputs is used as the control value (pv = Process Variable). If pv0 is selected, Input 1 (Spike thermocouple) is used. If pv1 is selected, Input 2 (Process thermocouple) is used. This command applies only to 2000 Series controllers and is not used on channels assigned to Models 808/814.

Gn0/Gn1
Some Eurotherm models support two different sets of PID constants. The ***Tymkon*** software can optionally link PID Table 1 to Input 1 (Spike T/C) and PID Table 2 to Input 2 (Process T/C). This capability is usually disabled in the Tymkon ROM when the user intends to use the temperature controllers with Gain Scheduling enabled. When Gain Scheduling is enabled, the Eurotherms automatically select PID Table 1 at setpoints below the Gain Schedule trip level and PID Table 2 at setpoints equal to or above the Gain Schedule trip level.

Note: The Eurotherm controllers ignore any 'Gn' commands received from the Tymkon when Gain Scheduling is enabled. Dual input controllers must have the following parameters set in order for the temperature controller to select the PID table based on the temperature setpoint:

'Ctrl' set to 'Pid' in the 'InSt ConF' menu
'GSch' set to 'Yes' in the 'InSt ConF' menu
'Func' set to 'nonE' in the 'LA ConF' menu
'Func' set to 'nonE' in the 'Lb ConF' menu

The following set of parameters apply when the Tymkon is configured to select the PID table based on the selected thermocouple:
'Ctrl' set to 'Pid' in the 'InSt ConF' menu
'GSch' set to 'no' in the 'InSt ConF' menu
'Func' set to 'nonE' in the 'LA ConF' menu
'Func' set to 'nonE' in the 'Lb ConF' menu

SS0/SS1
Controllers that support two inputs allow for two different setpoints. The ***Tymkon*** software links Setpoint 1 to Input 1 and Setpoint 2 to Input 2. The only reason for doing this is to take advantage of the Eurotherm front panel display to notify the user which thermocouple is in control. When Setpoint 2 is selected, the Eurotherm 2408 displays “SP2”. Unfortunately, the user may assume that “SP” refers to Spike, whereas it actually refers to “Setpoint 2” which is typically the Process thermocouple.

SL
The previous three commands are used only on two-input temperature controllers. The “SL” command is used with all controllers. The “SL” command sends a 4-digit value from the ***Tymkon*** to the Eurotherm. On two-input controllers, the value is stored either in Setpoint 1 or Setpoint 2 as determined by the most recent SS0/SS1 command.

PV
The “PV” query reads the current Process Variable thermocouple as determined by the most recent pv0/pv1 command. Because of that ambiguity, this command in only used with Models 808 and 814 that do not include two-inputs.

QY
The “QY” query reads Input 1 thermocouple (Spike) regardless of which input is currently selected. This query is used with two-input controllers to remove ambiguity and is not supported on Models 808 and 814.

QZ
The “QZ” query reads Input 2 thermocouple (Process) regardless of which input is currently selected. This query is used with two-input controllers to remove ambiguity and is not supported on Models 808 and 814.

3.23.4.4. Eurotherm Message Stream Examples

When the ***Tymkon*** communications with a Eurotherm Model 808 or 847, the following messages are exchanged:

<EOT>0000<STX>SLxxxx.<ETX><BCC> <wait for response>
<EOT>0000PV<ENQ> <wait for response>

The first command sequence sends a setpoint to the Model 808/847. The "xxxx" characters in the command represent the value of the temperature setpoint.

The second sequence requests the Model 808/847 to transmit its *Present Value* to the ***Tymkon***.

When the ***Tymkon*** communications with a dual-input Eurotherm Model 2408 or 2216, a more extensive list of messages are exchanged:

<EOT>0000<STX>pv0<ETX><BCC> <wait for response>
<EOT>0000<STX>Gn0<ETX><BCC> <wait for response>
<EOT>0000<STX>SS0<ETX><BCC> <wait for response>
<EOT>0000<STX>SLxxxx.<ETX><BCC> <wait for response>
<EOT>0000QY<ENQ> <wait for response>

<EOT>0000QZ<ENQ> <wait for response>

Note that the '0000' in the previous examples is replaced with the device ID of the particular temperature controller, and the '0' (as in pv0, Gn0 etc.) becomes either '0' or '1' depending on whether the Spike T/C or the Process T/C is in control. Also, the 'Gn' message is omitted from the message stream when Gain Scheduling is enabled.

3.23.5. Temperature Control using DTC Temperature Controllers

A Tymkon accessory board provides up to (8) additional relay outputs on any 16-output Tymkon. This board, part number 9990366, sub-assembly 810-0050, may be configured to provide recipe select signals for the DTC Temperature Controller. The DTC Temperature Controller has a set of (4) digital inputs that may be used to select one of 16 possible temperature-control 'recipes'. Note: In the case of the DTC, a 'recipe' is not a sequence of cycles as it is in Tymkon terminology. Instead, a DTC recipe represents a set of set-points and control parameters for the various furnace zones.

The Tymkon software may be configured to operate the DTC Recipe-Select relays in one of two different modes. The less desirable way is to assign an output function to be used as 'DTC Recipe Select'. In this configuration, the user programs the analog channel for a value from 0 to 15 as part of a Process Segment definition. The Tymkon software then sends to the DTC a binary value equal to the number of the selected 'recipe'.

The second technique is more desirable and more frequently used. In this approach, the user programs the desired recipe number using the Tymkon's Programming Mode 4. In this case, the DTC Recipe is programmed on a cycle-by-cycle basis rather than as part of a Process Segment table. Just as in standard Mode 4 programming, the 'DTC Recipe Select' relays stay in the previous state during any cycle in which the user does not program a specific set-point value.

3.23.6. Temperature Control using Anafaze PPC Temperature Controllers

When the Anafaze PPC is used to control furnace temperature, the Tymkon sends setpoints to the PPC, and the PPC provides closed-loop PID control.

There are two PC-based software applications that may be used to configure and monitor operation of the PPC; LogicPro and AnaWin.

LogicPro is an application supplied by Watlow that is used to generate and download a runtime program that supplements the basic PID software native to the PPC. The program downloaded to the PPC is created by the equipment provider and determines the conditions under which the PPC controls by process thermocouples as opposed to spike thermocouples. In addition, that program places thermocouple readings in memory locations that the Tymkon has access to using MODBUS protocol. Once LogicPro has downloaded its application to the PPC, LogicPro is no longer needed. Most end-users would not need to own a copy of LogicPro.

AnaWin may be used by the end-user to monitor, and to some extent, control operation of the PPC. Anawin provides graphing capability as well as the ability to set alarm thresholds and PID parameters.

3.23.6.1. Anafaze Variable List

The Tymkon communicates with the PPC using MODBUS RTU protocol. Basically, the PPC exposes certain memory locations (registers) to MODBUS serial ports. The Tymkon may write to any of these locations or read from them. The specific locations used in this application are referred to as “Soft Integers”. Each Soft Integer consists of two bytes (16-bits) of information.

The table below lists the registers accessed by the Tymkon. As shown, Integers 1 through 10 contain data sent from the Tymkon to the PPC, and Integers 11 through 20 contain data made available to the Tymkon by the LogicPro application.

Variable	Decimal Address	Hex Address	Function	Description
Int 1	6300	189C	Setpoint 1	Load
Int 2	6301	189D	Setpoint 2	Center
Int 3	6302	189E	Setpoint 3	Source
Int 4	6303	189F	Setpoint 4	(unused)
Int 5	6304	18A0	Setpoint 5	(unused)
Int 6	6305	18A1		
Int 7	6306	18A2		
Int 8 *	6307	18A3	Cycle	Tymkon Cycle Number
Int 9	6308	18A4	Control 1	0=Spike, 1=Process
Int 10	6309	18A5	Control 2	Target Temperature
Int 11	6310	18A6	Actual 1	Spike 1, Load
Int 12	6311	18A7	Actual 2	Spike 2, Center
Int 13	6312	18A8	Actual 3	Spike 3, Source
Int 14	6313	18A9	Actual 4	Process 1, Load
Int 15	6314	18AA	Actual 5	Process 2, Center
Int 16	6315	18AB	Actual 6	Process 3, Source
Int 17	6316	18AC	Actual 7	
Int 18	6317	18AD	Actual 8	
Int 10	6318	18AE	Status 1	
Int 20	6319	18AF	Status 2	

The Tymkon communicates with the PPC every three seconds. The contents of the communications alternates each three seconds between a command sequence, during which Int’s 1 through 10 are transmitted, and a Query sequence, during which Int’s 11 through 20 are read.

* Note: Software running in the Anafaze multiplies the cycle number by 100 and puts the result in one of the Anafaze’s unused Channel Setpoints. The resultant value ranges from 0 to 630.0 as the Tymkon recipes advances from cycle 0 to cycle 63. This value is in the same range as normal temperature readings and, thus, may be plotted on a trend chart along with actual temperature readings. Progression of the Tymkon recipe from cycle to cycle is then obvious on the plots.

3.23.6.2. Mode 4, Temperature Setpoints

Mode 4 is the designation given to those Tymkon programming functions that allow the user to enter temperature setpoints for as many Cycles as required. When the PPC is used with the Tymkon, Mode 4 behaves generally as described in the Tymkon Instruction Manual. One significant difference is that the ENTER key may be used to toggle the temperature setpoint between "S" (spike T/C) mode and "P" (Process T/C) mode. When the target temperature is set to a "P" value, the Tymkon sends a flag to the PPC using Soft Int 9. The LogicPro application running at the PPC then switches control to the Process T/C's.

In some installations, the status of the Spike/Process control mode is displayed on a Tymkon output function. Typically, the Tymkon output LED lights when the Process T/C's are being used for control.

3.23.6.3. Mode 2, Drop Zones

Tymkon software normally allows the use of Auxiliary Commands in any Cycle of any Recipe. These commands occupy a cycle in place of a Process Segment. Some of the commands have arguments, while others do not.

In some cases, it is desirable to force individual zone setpoints to a low value to allow the furnace to cool more rapidly. When Temperature Segments are used at the Tymkon, the setpoint for each zone may be set independently. However, many applications don't require the complexity introduced by the use of Temperature Segment tables. For those applications, the following 'Drop Zones' capability is provided.

Another case where the 'Drop Zones' capability is useful is when the Tymkon is programmed to 'Wait' until a target temperature is reached using Auxiliary Command 71 (see below). Since Command 71 waits for the programmed temperature to be reached, it may be desirable to program a non-zero target temperature, but yet force the power output of specified zones to 0 to promote rapid cooling.

When a Tymkon is used with a PPC, Auxiliary Command 72 is used to provide a way to force individual zones to a low setpoint. This effect continues until the recipe is complete, or until another Auxiliary Command 72 is executed. To enable or disable the 'Drop Zones' function, enter 72 at the desired point in the recipe using Mode 2. Then press the ENTER key and set it's argument to a value ranging from '0' to '7' as follows:

Value	Aux Command 72 Action
0	Cancel 'Drop Zones' function
1	Set Load Zone to '0'
2	Set Center Zone to '0'
3	Set Load & Center Zones to '0'
4	Set Handle Zone to '0'
5	Set Load & Handle Zones to '0'
6	Set Center & Handle Zones to '0'
7	Set all Zones to '0'

Note that these values are weighted such that the Load zone has a value of '1', the Center zone has a value of '2' and the Handle zone has a value of '4'. Different effects can be obtained by adding different combinations of 1,2 & 4.

To disable the 'Drop Zones' function later in the recipe, enter 72 at the desired point in the recipe, and set it's argument to '0'.

The status of the 'Drop Zones' mode is usually displayed on a Tymkon output function. Typically, the Tymkon output LED lights when any the 'Drop Zones' function is in effect.

3.23.6.4. Mode 2, Monitor Temperature

Another Auxiliary Command has been added to allow the user to create recipes that adapt to extended temperature ramps. The Auxiliary Command that controls this behavior is Command 71.

Command 71 has four valid arguments:

1 WAIT for SPIKE <= TARGET
2 WAIT for SPIKE >= TARGET
3 WAIT for PROFILE <= TARGET
4 WAIT for PROFILE >= TARGET

When the Tymkon encounters an Auxiliary Command 71 in a recipe, it advances to the next cycle, times-out the programmed cycle interval, and, then, begins to monitor the appropriate thermocouple. During the WAIT interval, a specified Digital Wait Input is asserted unsafe and it's LED is lighted. Once the temperature condition is satisfied, the Temperature Monitor Mode is cleared and the recipe is allowed to advance to the next Cycle.

The status of the 'Temperature Monitor Modes' is sometimes displayed on (4) Tymkon digital input functions or merged onto (1) function, depending on how many functions are available. Typically, the Tymkon input LED's light when one of the 'Temperature Monitor Modes' is in effect. The user does not need to program the Temperature Monitor Digital Inputs in the segment table – this behavior is automatic.

4. PROGRAMMING

Each ***Tymkon*** is a general-purpose process sequence controller. Except for any customized features or interlocks that may be included in the firmware, the behavior of a particular ***Tymkon*** is undetermined until process recipes have been entered into its memory.

The following discussion describes programming operations as performed from the ***Tymkon*** front panel. Any programming functions performed over a communications connection are determined by the software of the host computer and would be described in the host software manual.

Be aware that, during most programming operations, the front panel input/output LED's indicate the programmed status, not the actual status of the inputs and outputs.

4.1. Programming Overview

In order to simplify front panel programming, the numerous programmable functions are divided into several programming *modes*. Each mode configures or reviews some particular aspect of operation. A list of the standard programming modes follows:

MODE	ACTION
0	Clear the *Runs Counter* for the currently selected recipe.
1	Program library *Process Segments* (outputs and inputs).
2	Construct a *Recipe*.
3	Assign time intervals to cycles of the currently selected recipe.
4	Assign temperature values to cycles of the currently selected recipe.
5	
6	
7	
8	
9	
A	Review or clear *End-Of-Process Log.(obsolete – this feature is no longer available)*
B	Review or clear *Event Log.(obsolete – this feature is no longer available)*
C	
D	
E	
F	

Before entering data into the ***Tymkon's*** memory, it is useful to define the required recipes on a suitable paper programming form for documentation purposes. Examples of such forms can be found in the appendix of this manual.

Mode 1 programming permits the user to compose a library of *Process Segments* for use in any of the recipes. Using the form labeled **'Mode 1 - Process Segment Programming Form'**, define each segment of the process in terms of what it is to do. Specify each segment in terms of which control circuits must be energized to accomplish the desired function and which sensors must be monitored during that segment. At this stage, don't be concerned about getting the library *Process Segments* in the correct sequence; they do not have to be executed in numerical order. One segment can be reused several times during any recipe and can be assigned a different time interval each occurrence. Depending on software options, you can store either 32 or 64 segments in memory and recall them in any order. The only restrictions in the segment assignments are:

- At least one *Process Segment* must be reserved for the *Idle* state, (*Cycle 0*), even if *Idle* doesn't require any outputs to be energized. *Process Segment 0* is a good choice for use during *Cycle 0*.
- One *Process Segment* is used as a scratch pad for *Manual Mode* (usually *Segment 30*). This segment can also be assigned to cycles of recipes, but the user must be aware that its programming may be changed during *Manual Mode*.
- One *Process Segment* is activated during *Manual Abort* mode (usually *Segment 31*). This segment can be assigned to cycles of recipes as though it were a normal *Process Segment*.

Mode 2 programming composes *Process Segments* into recipes. Depending on software options, either 16 or 32 recipes can be stored in the memory. As recipes are defined, *Process Segments* are assigned to cycles to form a *Process Recipe*. A suggested form labeled **'Mode 2 and 3 - Process Recipe Programming Form'** is included in this manual for this purpose.

Mode 3 programming assigns a time interval to each cycle in a recipe and permits selection of a time base for each cycle. The form labeled **'Mode 2 and 3 - Process Recipe Programming Form'** used above for *Mode 2* programming is also useful for Mode 3 programming.

Mode 4 programming assigns a ramper setpoint to any cycle(s) in a recipe and permits selection of the polarity of that output. The form labeled **'Mode 2, 3 and 4 - Process Recipe Programming Form'** used above for *Modes 2* and *3* programming is also useful for *Mode 4* programming.

In order to make changes to data in memory, it is necessary that programming be enabled. This might be accomplished in one of several ways:

- On most cabinet-mounted units, place the **PROGRAM DISABLE** slide switch at the bottom of the rear panel in the **OFF** position.
- On Rotameter units, place the **PROGRAM ENABLE** slide switch on the rear panel in the **ON** position.
- On panel-mounted units, place the **OPERATE/PROGRAM** keylock in the **PROGRAM** position.

Note: The untrained user should never program or operate a process sequencer that is connected to a piece of equipment where unsafe combinations of outputs may be activated!

4.2. Mode 0 - Clear a *Runs Counter*

This mode resets the *Runs Counter* to zero for the currently selected recipe. The appropriate *Runs Counter* increments each time a recipe is completed. Each counter records and displays up to 99 runs per recipe. When greater than 99 runs have been processed, the display indicates: **>99R**.

4.2.1. Select the *Runs Counter* to clear as follows:

a.) Press the **MODE** pad. (Note: This optional step is only required when the ***Tymkon*** is currently running some recipe other than the one for which the *Runs Counter* is to be cleared.)

b.) Press the **RECIPE** pad to select recipes 0 through F. If the ***Tymkon*** being programmed contains 32 recipes instead of the normal 16, press the **RECIPE** pad a second time to select the second group of recipes.

c.) Press the pad corresponding to the number of the desired recipe. For example, to select *Recipe L*, press **RECIPE** twice, then press the key labeled **4**.

Key label:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**A**	**B**	**C**	**D**	**E**	**F**
1st group	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
2nd group	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X

4.2.2. Execute *Mode 0* as follows:

a.) Press the **MODE** pad.

b.) Press the **[0]** pad.

The *Runs Counter* for the selected recipe is now reset to zero.

4.3. Mode 1 - Define *Process Segments*

This mode is used to program:

- the outputs to be energized,
- the set-points of analog outputs,
- the inputs to be monitored, and
- a *Programmable Segment Alarm*.

In this programming mode, the individual keys on the keypad perform as follows:

Key	MODE 1 Keypad Functions
RECIPE	Unused.
STEP	Advances to the next library *Process Segment*.
CLEAR	Clears the function being programmed. It may be used to set an analog output to 0%, clear all outputs, or clear all inputs.
ENTER	Alternates function of keypad between outputs and inputs.
0 to **9**, **A** to **F**	Toggles the status of the corresponding output or input.
MODE	Terminates *Mode 1* programming.
ALARM	Toggles programmable alarm on or off and also retains its normal *Alarm Silence* function.
ABORT	Retains its normal *Manual Abort* function (if present).
RESET	Terminates *Mode 1* programming and retains its normal *Reset* function.
RUN/HOLD	Retains its normal *Run/Hold* function.

Using the **Process Segment Programming Form** from page 86 or page 87 or a similar matrix form, determine and record the pattern of digital outputs, analog values, and digital inputs for each *Process Segment*. Having completed the form, proceed with programming in the following manner:

4.3.1. Enter *Mode 1* as follows:

a.) Press the **MODE** pad.

b.) Press the **1** pad.

The alphanumeric display will read [**S=ss OUT]** where:

ss = *Process Segment* being programmed

4.3.2. If the current library segment had previously been programmed and no changes are required, you may step to the library segment you wish to program by pressing the **STEP** pad as many times as required.

4.3.3. Enter the pattern of outputs to be energized and any corresponding analog set points as follows:

a.) Press the pad corresponding to the desired output, **0** to **F**. On models with 16 or fewer outputs, this will toggle the desired output from off to on or vice versa.

b.) On those models that support more than 16 outputs, enter the two digits of the output number. When you press a number pad, that number will appear on the alphanumeric display as a flashing number and will replace the flashing word **OUT**. Double-digit numbers are entered one digit at a time and move from right to left on the alphanumeric display. The LED display corresponding to the selected output will not be toggled on or off until the **ENTER** pad is pressed, at which time the flashing number will be replaced by the flashing word **OUT**.

c.) When you have selected an output that has an analog function associated with it, the LED corresponding to the selected output will begin flashing and the alphanumeric display will change to: **SET= 00%**. To enter the desired analog output value, press the number pads for the particular value (i.e., **5** and **0** for 50%.) The display will now read: **SET= 50%**. Press the **ENTER** pad to continue output programming.

Note: If you toggle off an output that has an analog associated with it, the corresponding LED display will cease to be illuminated; however, the percentage value will remain in memory and will reappear the next time the particular analog output is activated in this particular *Process Segment*.

4.3.4. Continue this procedure until all of the desired outputs for the particular library segment being programmed have been entered.

4.3.5. If you wish to have a *Programmable Segment Alarm* sound whenever this segment is used, press the **ALARM** pad.

The alphanumeric display will now read **S=ss*OUT** where:

***** = indicates that the *Programmable Segment Alarm* is set

4.3.6. If you wish to program a pattern of inputs to be monitored whenever this *Process Segment* is used, press the **ENTER** Key.

The alphanumeric display will now read **S=ss INP** where:

ss = *Process Segment* being programmed

4.3.7. You may now program the inputs for the particular *Process Segment* in a manner similar to that used to program the outputs.

4.3.8. Having completed programming the outputs, analog values, and inputs for a particular *Process Segment*, press the **STEP** pad to advance to the next *Process Segment*. If you had been programming *Segment 0*, the alphanumeric display will now read: **S=01 OUT**. Using the procedure listed above, you may program as many of the library *Process Segments* as desired. There are at least 32 library *Process Segments*, but they do not all have to be programmed at this time.

4.3.9. Press the **MODE** pad twice at any time to exit any programming mode.

4.4. Mode 2 - Construct a *Recipe*

This mode is used to enter:

- The *Process Segment* to be used for each cycle, and
- The *Branch Destination Cycle* for each cycle, and
- A *Programmable Cycle Alarm* if desired.

In this programming mode, the individual keys on the keypad perform as follows:

Key	MODE 2 Keypad Functions
RECIPE	Unused.
STEP	Adds an additional cycle to the recipe being programmed. (Note: On those models which include the *Manual Mode* option, *Recipe 0* has one and only one cycle, *Cycle 0*. In this case, the **STEP** pad will not permit advancing from *Cycle 0* to *Cycle 1*.)
CLEAR	Terminates the recipe at the current cycle and erases any subsequent cycles that may have been previously programmed.
ENTER	Alternates function of keypad between *Process Segment* and *Branch Destination Cycle*.
0 to **9**	Enters numeric data.
A to **F**	Unused.
MODE	Terminates *Mode 2* programming.
ALARM	Toggles *Programmable Cycle Alarm* on or off and also retains its normal *Alarm Silence* function.
ABORT	Retains its normal *Manual Abort* function (if present).
RESET	Terminates *Mode 2* programming and retains its normal *Reset* function.
RUN/HOLD	Retains its normal *Run/Hold* function.

Using the **Recipe Programming Form** on page **Error! Bookmark not defined.** or a similar matrix form, identify the process recipe to be programmed and assign a *Process Segment* to each process cycle. Assign a *Branch Destination Cycle* to any process cycle where you want interlock branching to occur. If desired, assign a *Programmable Cycle Alarm* to any cycles requiring operator attention. Having completed the form, proceed with programming in the following manner:

4.4.1. Select the recipe to program as follows:

a.) Press the **MODE** pad. (Note: This optional step is only required when the ***Tymkon*** is currently running some recipe other than the one to be programmed.)

b.) Press the **RECIPE** pad to select recipes 0 through F. If the ***Tymkon*** being programmed contains 32 recipes instead of the normal 16, press the **RECIPE** pad a second time to select the second group of recipes.

c.) Press the pad corresponding to the number of the desired recipe. For example, to select *Recipe L*, press **RECIPE** twice, then press the key labeled **4**.

Key label:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**A**	**B**	**C**	**D**	**E**	**F**
1st group	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
2nd group	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X

4.4.2. Enter *Mode 2* as follows:

a.) Press the **MODE** pad.

b.) Press the **2** pad.

The alphanumeric display will read **[rcc S=ss]** where:

r = *Recipe* being programmed
cc = *Cycle* being assigned a *Process Segment*
ss = *Process Segment* assigned to this cycle

4.4.3. Using the numeric keypad, enter the number of the desired *Process Segment* (i.e., 0 to 31). If the number is a double digit number, press both digits of the number (i.e., **1** and **0** for 10).

4.4.4. If you wish to have the *Programmable Cycle Alarm* sound whenever this cycle is executed, press the **ALARM** pad.

The alphanumeric display will now read **[rcc*S=ss]** where:

***** = indicates that the alarm is set

4.4.5. If you wish to program a *Branch Destination Cycle* for this process cycle, press the **ENTER** key.

The alphanumeric display will now read **[rcc B=bc]** where:

r = *Recipe* being programmed
cc = *Cycle* being programmed
bc = *Branch Destination Cycle* assigned to this process cycle

4.4.6. Using the numeric keypad, enter the number of the desired *Branch Destination Cycle* (i.e., 1 to 99).

4.4.7. Press the **STEP** pad to advance to the next cycle and repeat the procedure for each process cycle to be programmed.

4.4.8. When the last cycle has been added, press the **CLEAR** pad to insure that no cycles remain from some previously programmed process. In *Mode 2*, the **CLEAR** pad erases memory from the current cycle to the end of the recipe.

Note: Each time the **STEP** pad was pressed above, an additional cycle was added to the recipe being programmed. The last cycle to be added when you exit this programming mode becomes the *Countup Cycle* at the end of the recipe.

4.4.9. Press the **MODE** pad twice at any time to exit any programming mode.

4.5. Mode 3 - Assign Cycle Times

This mode is used to assign times to each cycle of a process recipe.

In this programming mode, the individual keys on the keypad perform as follows:

Key	MODE 3 Keypad Functions
RECIPE	Unused.
STEP	Advances to the next cycle.
CLEAR	Clears the time for this cycle to **0000**.
ENTER	Alternates time base between minutes and seconds.
0 to **9**	Enters numeric data.
A to **F**	Unused.
MODE	Terminates *Mode 3* programming.
ALARM	Retains its normal *Alarm Silence* function.
ABORT	Retains its normal *Manual Abort* function (if present).
RESET	Terminates *Mode 3* programming and retains its normal *Reset* function.
RUN/HOLD	Retains its normal *Run/Hold* function.

Using the **Recipe Programming Form** on page **Error! Bookmark not defined.** or a similar matrix form, identify the process recipe to be programmed and assign a time duration to each process cycle. Any process cycles to be bypassed may be programmed with a time of 000.0. Note that *Wait Inputs* and *Programmable Holds* may cause a cycle time to be extended even in those cycles programmed for a duration of 000.0. Having completed the form, proceed with programming in the following manner:

4.5.1. Select the recipe to program as follows:

a.) Press the **MODE** pad. (Note: This optional step is only required when the ***Tymkon*** is currently running some recipe other than the one to be programmed.)

b.) Press the **RECIPE** pad to select recipes 0 through F. If the ***Tymkon*** being programmed contains 32 recipes instead of the normal 16, press the **RECIPE** pad a second time to select the second group of recipes.

c.) Press the pad corresponding to the number of the desired recipe. For example, to select *Recipe L*, press **RECIPE** twice, then press the key labeled **4**.

Key label:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**A**	**B**	**C**	**D**	**E**	**F**
1st group	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
2nd group	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X

4.5.2. Enter *Mode 3* as follows:

a.) Press the **MODE** pad.

b.) Press the **3** pad.

The alphanumeric display will read **[rccxtttt]** where:

r = *Recipe* being programmed
cc = *Cycle* being programmed
x = **'** for minutes or **"** for seconds
tttt = Time assigned to this cycle.

4.5.3. Using the numeric keypad, enter the time assigned to the cycle being displayed. The format of the display is **ttt.t** minutes or **ttt.t** seconds. At any point, the time base selection may be changed by pressing the **ENTER** pad. A tic mark (**'**) appears before the time display if minutes are selected; a quote mark (**"**) indicates seconds.

4.5.4. Press the **STEP** pad to advance to the next cycle and repeat the previous step for each process cycle to be programmed.

4.5.5. Press the **MODE** pad twice at any time to exit any programming mode.

4.6. Mode 4 - Enter Ramper Setpoints

This mode is used to assign a setpoint to any cycle of a process recipe for which ramping is desired. Depending on hardware configuration, this setpoint may be translated to an analog output via a digital-to-analog converter or it may be transmitted to a temperature controller via EIA-232.

With the ***Tymkon***, it is not necessary or advisable to assign a ramper setpoint to those cycles in which the temperature will be held constant. In those cycles where ramping is not programmed, the setpoint is displayed as **N/C** (**NO CHANGE**) while active ramper setpoints are displayed as numeric values from -9999 to +9999. On power-up, all setpoints are cleared to **N/C**. During cycles with an **N/C** setpoint, the ramper output remains unchanged from its most recent active value.

Changes made to the ramper setpoint during *Mode 4* programming are not implemented while the cycle being programmed equals the cycle being executed. This prevents arbitrary temperature fluctuations during programming.

The analog setpoint is not ramped during *Cycle 0* and during the *Countup Cycle* at the end of any recipe. During these cycles, the programmed setpoint is executed immediately.

The value programmed for *Cycle 0* of a particular recipe is used for the *Idle* condition and as the beginning point for ramping. The output value programmed for the *Countup Cycle* is the final output value and terminates ramping.

It is advisable to program an analog setpoint for *Cycle 0* of each recipe whether or not the temperature will ramp during the recipe. This assures a known starting point regardless of the status of the analog output when the recipe was first selected.

The output value that is programmed into each timed cycle is the setpoint desired at the end of that cycle. The ***Tymkon*** starts at the value programmed for the most recent cycle that had a numeric setpoint (other than **N/C**), and ramps to the new output value linearly over the time period programmed into the current cycle.

The ramp rate is recalculated each second based on:

- The assumed beginning setpoint,
- The programmed final setpoint,
- The programmed duration of the cycle and
- The elapsed time.

In this programming mode, the individual keys on the keypad perform as follows:

Key	MODE 4 Keypad Functions
RECIPE	Unused.
STEP	Advances to the next cycle.
CLEAR	Sets the display to **N/C**, which means the analog output will not change from the last time it was set.
ENTER	Alternates the polarity of the output between positive and negative.
0 to **9**	Enters numeric data.
A to **F**	Unused.
MODE	Terminates *Mode 4* programming.
ALARM	Retains its normal *Alarm Silence* function.
ABORT	Retains its normal *Manual Abort* function (if present).
RESET	Terminates *Mode 4* programming and retains its normal *Reset* function.
RUN/HOLD	Retains its normal *Run/Hold* function.

Using the **Recipe Programming Form** on page **Error! Bookmark not defined.** or a similar matrix form, identify the process recipe to be programmed and record a ramper setpoint for each process cycle to be ramped. Having completed the form, proceed with programming in the following manner:

4.6.1. Select the recipe to program as follows:

a.) Press the **MODE** pad. (Note: This optional step is only required when the ***Tymkon*** is currently running some recipe other than the one to be programmed.)

b.) Press the **RECIPE** pad to select recipes 0 through F. If the ***Tymkon*** being programmed contains 32 recipes instead of the normal 16, press the **RECIPE** pad a second time to select the second group of recipes.

c.) Press the pad corresponding to the number of the desired recipe. For example, to select *Recipe L*, press **RECIPE** twice, then press the key labeled **4**.

Key label:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**A**	**B**	**C**	**D**	**E**	**F**
1st group	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
2nd group	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X

4.6.2. Enter *Mode 4* as follows:

a.) Press the **MODE** pad.

b.) Press the **4** pad.

The alphanumeric display will read **[rccptttt]** where:

r = *Recipe* being programmed.
cc = *Cycle* being programmed.
p = Polarity of ramper output (**+** or **-**).
tttt = Ramper setpoint assigned to this cycle or **N/C** for no change.

4.6.3. Using the numeric keypad, enter the ramper setpoint for the cycle being displayed. The format of the display is **+t.ttt** for positive outputs or **-t.ttt** for negative outputs. If the sign of the offset is to be changed, press the **ENTER** key to toggle from **+** to **-** or from **-** to **+**.

4.6.4. Press the **STEP** pad to advance to the next cycle.

4.6.5. Repeat the previous procedure for each process cycle to be programmed.

See example below:

Cycle	Time Setpoint	Ramper Setpoint	Result
0		**+0750**	Idle - Ramper outputs 0.750 volts, 0.750 millivolts or 750 degrees depending on hardware present.
1	**'0100**	**+1250**	Ramps to 1250 over 10.0 minute period.
2	**'1000**	**N/C**	Stays at 1250 for 100.0 minutes.
3	**'1000**	**+1000**	Ramps back down to 1.000 over 100.0 minute period.
4	**'0500**	**N/C**	Stays at 1.000 for 50.0 min.
5	**"1200**	**+0750**	Ramps to 0.750 from 1.000 over this 120 second cycle.
6		**+0000**	Goes to zero output at end of process.

4.6.6. Press the **MODE** pad twice at any time to exit any programming mode.

4.7. Mode A - Review the End-of-Recipe Log

Note: This feature is no longer available. More detailed data logs are provided by the widely available PC-based host software. Information is provided below to support legacy applications.

This mode is used to access or clear the *End-Of-Recipe Log*. While in *Mode A*, the **STEP** key steps through all entries from the most recent to the oldest. The **CLEAR** key, if programming is enabled, erases the entire table.

In this programming mode, the individual keys on the keypad perform as follows:

Key	MODE A Keypad Functions
RECIPE	Unused.
STEP	Advances to the next log entry.
CLEAR	Clears the *End-Of-Recipe Log*.
ENTER	Unused.
0 to **9**	Unused.
A to **F**	Unused.
MODE	Terminates *Mode A* programming.
ALARM	Retains its normal *Alarm Silence* function.
ABORT	Retains its normal *Manual Abort* function (if present).
RESET	Terminates *Mode A* programming and retains its normal *Reset* function.
RUN/HOLD	Retains its normal *Run/Hold* function.

4.7.1. Enter *Mode A* as follows:

a.) Press the **MODE** pad.

b.) Press the **A** pad.

The alphanumeric display will read **[RUN -##]** where:

= number from 1 to 64 (1 is the most recent run recorded and 64 is the oldest).

Note: See page 37 for a detailed explanation of the display format.

4.7.2. Press the **STEP** pad to examine the next oldest run.

4.7.3. Repeat the previous step as desired.

4.7.4. Press the **CLEAR** pad at any time to erase the entire list.

4.7.5. Press the **MODE** pad twice at any time to exit any programming mode.

4.8. Mode B - Review the Event Log

Note: This feature is no longer available. More detailed data logs are provided by the widely available PC-based host software. Information is provided below to support legacy applications.

This mode is used to review the *Event Log*. While in *Mode B*, the **STEP** key steps through all entries from the beginning of the recipe to the end. No other keys are used.

In this programming mode, the individual keys on the keypad perform as follows:

Key	MODE B Keypad Functions
RECIPE	Unused.
STEP	Advances to the next log entry.
CLEAR	Unused.
ENTER	Unused.
0 to **9**	Unused.
A to **F**	Unused.
MODE	Terminates *Mode B* programming.
ALARM	Retains its normal *Alarm Silence* function.
ABORT	Retains its normal *Manual Abort* function (if present).
RESET	Terminates *Mode B* programming and retains its normal *Reset* function.
RUN/HOLD	Retains its normal *Run/Hold* function.

4.8.1. Enter *Mode B* as follows:

a.) Press the **MODE** pad.

b.) Press the **B** pad.

The alphanumeric display will read **[#ee XXXX]** where:

ee = the number of the event currently being displayed.

Note: See page 38 for a detailed explanation of the display format.

4.8.2. Press the **STEP** pad to examine the next event in the list.

4.8.3. Repeat the previous step as desired.

4.8.4. Press the **CLEAR** pad at any time to erase the entire log. In any case, the log will automatically be cleared at the beginning of the next recipe.

4.9. Repeat *Power-On-Self-Test*

This function enables the user to perform a diagnostic selftest without disabling the backup battery or erasing existing recipes. In addition, it permits examination of the configuration number and software revision date without powering down the unit.

Unlike other programming modes, this function may not be performed while a recipe is running. The *Power-On-Self-Test* forces the ***Tymkon*** to *Cycle 0* (*Idle*) of a specific recipe (usually *Recipe 1*) and also initializes most variables; therefore, its use is software restricted as follows:

- The power-up recipe (usually *Recipe 1*) must be selected,
- The ***Tymkon*** must be in *Cycle 0*, *Idle,* thereby not executing a recipe, and
- Programming must be enabled.

As when *Power-On-Self-Test* is executed during power-up, the user is given the option of clearing all existing recipes.

To call up the *Power-On-Self-Test* ,

4.9.1. Insure that the ***Tymkon*** is not executing a recipe.

4.9.2. Select the power-up recipe (usually *Recipe 1* unless otherwise specified).

4.9.3. Press the **9** key twice. Display should read **[KEYS= 99]**

4.9.4. Press and release **ENTER**.

4.9.5. Observe the various phases of selftest as described on page 72.

4.9.6. When the alarm sounds at the completion of *Power-On-Self-Test*, momentarily press **RESET**.

4.10. Programming Exercise

Following is a list of ***Tymkon*** instructions which may be used as a learn-by-doing programming tutorial. Alphanumeric displays are indicated by the symbols **[ ]** and keys to be pressed are indicated in the following print style: **RESET**.

Note: The untrained user should never program or operate a process sequencer that is connected to a piece of equipment where unsafe combinations outputs may be activated!

In order to make changes to data in memory, it is necessary that programming be enabled. This might be accomplished in one of several ways:

- On most cabinet-mounted units, place the **PROGRAM DISABLE** slide switch at the bottom of the rear panel in the **OFF** position.
- On Rotameter units, place the **PROGRAM ENABLE** slide switch on the rear panel in the **ON** position.
- On panel-mounted units, place the **OPERATE/PROGRAM** keylock in the **PROGRAM** position.

Step 1.) Press: **RESET** Display: **[r 0 xxR]**
You have now abandoned any recipe that may have been running and exited any programming mode. **r** indicates which recipe is currently selected and **xx** indicates the number of *Completed Runs* for that recipe.

Step 2.) Press: **RECIPE** Display: **[REC 0-F?]**
Press: **1** Display: **[1 0 xxR]**
You have selected *Recipe 1*. **xx** now indicates the number of completed runs for *Recipe 1*.

Step 3.) Press: **MODE** Display: **[MODE ?]**
Press: **1** Display: **[S=00 OUT]**
You have selected *Mode 1* programming.

Step 4.) Press: **STEP** Display: **[S=01 OUT]**
You have bypassed *Segment 0* and advanced to *Segment 1*.

Step 5.) Press: **1** Display: **[S=01 OUT]**
6 Display: **[S=01 OUT]**
7 Display: **[S=01 OUT]**
You have selected outputs 1, 6 & 7 to be energized during *Segment 1*. These are all digital-only outputs, so analog set-points are not required.

Step 6.) Press: **A** Display: **[SET= 00%]**
Since you have selected an output that controls an analog function, the software is asking for its setpoint.

Step 7.)	Press: **5** Display: **[SET= 05%]** **4** Display: **[SET= 54%]** **ENTER** Display: **[S=01 OUT]** You have entered a setpoint of 54% for *Analog Output A* in *Segment 1*.	
Step 8.)	Press: **ENTER** Display: **[S=01 INP]** You have toggled to input programming for *Segment 1*.	
Step 9.)	Press: **1** Display: **[S=01 INP]** You have selected input 1 to be monitored during *Segment 1*.	
Step 10.)	Press: **STEP** Display: **[S=02 OUT]** You have stepped to the next *Process Segment*.	
Step 11.)	You may now repeat Steps 5.) through 10.) to practice programming additional *Process Segments*.	
Step 12.)	Press: **MODE** Display: **[MODE ?]** **2** Display: **[1 0 S=00]** You have selected *Mode 2* programming and may now assign a *Process Segment* to *Cycle 0* of *Recipe 1*.	
Step 13.)	Press: **1** Display: **[1 0 S=01]** **3** Display: **[1 0 S=13]** You have assigned *Segment 13* to *Cycle 0* of *Recipe 1*.	
Step 14.)	Press: **STEP** Display: **[1 1 S=00]** You have advanced to *Cycle 1*.	
Step 15.)	Press: **1** Display: **[1 1 S=01]** You have assigned *Segment 1* to *Cycle 1* of *Recipe 1*. Notice that the discrete LED's now indicate the outputs previously programmed for *Segment 1*.	
Step 16.)	Press: **ENTER** Display: **[1 1 B=01]** You have toggled to *Branch Destination Cycle* programming.	
Step 17.)	Press: **7** Display: **[1 1 B=07]** You have programmed the ***Tymkon*** to branch to *Cycle 7* if an interlock fails during *Cycle 1* of *Recipe 1*.	
Step 18.)	Press: **STEP** Display: **[1 2 S=00]** You have added an additional cycle to the current recipe.	
Step 19.)	You may now repeat steps 15.) through 18.) as desired to practice programming additional *Cycles*.	

Step 20.) Press: **MODE** Display: **[MODE ?]**
3 Display: **[1 1'0000]**
You have selected *Mode 3* programming and may now assign times to each cycle of the recipe.

Step 21.) Press: **3** Display: **[1 1'0003]**
5 Display: **[1 1'0035]**
You have programmed this cycle for 3.5 minutes.

Step 22.) Press: **ENTER** Display: **[1 1"0035]**
You have changed the time base for this cycle to seconds.

Step 23.) Press: **STEP** Display: [**1 2'0000]**
You have advanced to the next cycle.

Step 24.) You may now repeat Steps 21.) through 23.) as desired to practice programming additional *Cycles*.

Step 25.) Press: **MODE** Display: **[MODE ?]**
4 Display: **[1 0 N/C]**
You have selected *Mode 4* programming and may now assign ramper values to each cycle of the recipe.

Step 26.) Press: **1** Display: **[1 0+0001]**
2 Display: **[1 0+0012]**
5 Display: **[1 0+0125]**
8 Display: **[1 0+1258]**
You have programmed the ramper for this cycle for 1.258 volts, millivolts or degrees Celsius.

Step 27.) Press: **ENTER** Display: **[1 0-1258]**
You have changed the ramper to -1.258 volts, millivolts or degrees Celsius.

Step 28.) Press: **STEP** Display: **[1 1 N/C]**
You have advanced to the next cycle.

Step 29.) You may now repeat Steps 26.) through 28.) as desired to practice programming additional *Cycles*.

Step 30.) Press: **MODE** Display: **[MODE ?]**
MODE Display: **[1 0 00R]**
You have exited the programming mode.

5. OPERATION

5.1. Executing Power-On-Self-Test

5.1.1. After installation of a ***Tymkon***, the Ni-Cad battery should be disconnected from the power supply before AC power is applied to the unit. This permits the microprocessor circuitry to properly initialize itself. Disable the battery as follows:

- On most cabinet-mounted units, place the **BATTERY ENABLE** slide switch at the bottom of the rear panel in the **OFF** position.
- On panel-mounted units, place the **OPERATE/PROGRAM** keylock in the **PROGRAM** position.

5.1.2. If the equipment to which the ***Tymkon*** is attached contains a remote, mechanically latched **RUN/HOLD** switch, make sure it is not in the **RUN** position.

5.1.3. Apply power. As the software performs its *Power-On-Self-Test*, messages similar to the ones listed below will be displayed in sequence:

[TYMKON]=	An 8-character name assigned during manufacturing. This is often the name of the company that built the equipment that the ***Tymkon*** is controlling.
[800-0286]=	An identification number assigned to this particular configuration.
[11/02/01]=	This is the software revision date.
[CLEAR?]=	If memory contains recipes that were protected by the EEROM and the Program/Operate switch is in the Program position, this prompt asks permission of the user to erase them. If the user responds within a few seconds by pressing the **CLEAR** key, all memory will be erased.
[DATA OK!]=	If memory contains recipes that were protected by the EEROM and the Program/Operate switch is in the Operate position, this prompt informs the user that existing recipes were detected.
[RAM TEST]=	Indicates that RAM is being pattern-tested and cleared.
[ROM TEST]=	Indicates that ROM is being validated against a previously stored checksum.
[50 HZ OK]=	Indicates *Power-On-Self-Test* is complete and the line frequency is 50 Hertz.
[60 HZ OK]=	Indicates *Power-On-Self-Test* is complete and the line frequency is 60 Hertz.

5.1.4. In most cases, when *Power-On-Self-Test* is complete, the alarm sounds indicating the ***Tymkon*** is ready to be programmed or operated. In some configurations, this alarm is disabled and the Tymkon proceeds to standby.

5.1.5. If necessary, press **RESET** to silence alarm.

5.1.6. Turn the **BATTERY ENABLE** switch to **ON** (up) or the **PROGRAM/OPERATE** switch to **OPERATE**. This serves three purposes:

- The Ni-Cad battery helps stabilize the power supply during spurious power dips, and
- The charging circuitry only operates when the battery is enabled,
- The battery must be enabled in order to provide backup power during AC power failures.

5.2. Selecting a Recipe

Depending on the software configuration, the ***Tymkon*** operating system accommodates either 16 or 32 process recipes. Regardless of recipe capacity, *Recipe 0* is usually reserved for *Manual Mode* and cannot be used as a normal time-sequenced recipe.

Since the front panel of the ***Tymkon*** has only 16 keys available to select a recipe, configurations that support 32 recipes divide these recipes into two groups of 16 recipes each.

To select a recipe in the 1st. group, 0 to F, press **RECIPE**, then press the key corresponding to the desired recipe.

To select a recipe in the 2nd. group, press **RECIPE** a second time, then press the key corresponding to the desired recipe as indicated in the table below. For example, to select *Recipe L*, press **RECIPE** twice, then press the key labeled **4**.

Key label:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**A**	**B**	**C**	**D**	**E**	**F**
1st set	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
2nd set	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X

5.3. Operating in Manual Mode

Note: In most configurations, a **PROGRAM DISABLE** slide switch or a **PROGRAM/OPERATE** keylock switch prohibit accidental changes to the output pattern in *Manual Mode*.

5.3.1. On those models that include the *Manual Mode* option, *Recipe 0* is reserved for *Manual Mode* operation. It does not sequence like the other recipes.

5.3.2. The *Manual Mode* is enabled by selecting *Recipe 0* in the following manner.
- a.) Insure that the Tymkon is in standby (Cycle 0) of any recipe.
- b.) Press the **RECIPE** pad to active the ‘Select Recipe’ mode.
- c.) Press the **[0]** pad to select Recipe 0.
- d.) Press **RUN/HOLD** pad to activate *Manual Mode*.

5.3.3. The alphanumeric display now displays the word **[MANUAL]**.

5.3.4. Output functions can now be toggled from the keypad in a manner similar to *Mode 1* programming (see page 55) with the following exceptions:
- a.) The **ENTER** pad will not switch from outputs to inputs. Programming of inputs is inhibited while in *Manual Mode*.
- b.) The **STEP** pad will not advance to the next *Process Segment* or *Cycle*.

5.3.5. Just as in *Mode 1* programming, when a function that requires an analog setpoint is toggled from *OFF* to *ON*, the operating system prompts the user for a setpoint value ranging from 0 to 99%. While the system is prompting for a setpoint, the alphanumeric display indicates both the actual value of the parameter being programmed and its current setpoint. This display mode is very useful for observing a gas flow as it ramps to its setpoint.

Normally, if a particular function is already *ON* and the user wants to return to this display mode, he must toggle the function *OFF* and then back *ON*. In some cases, turning a function off momentarily is undesirable because it resets an interlock timer (such as ‘O2 must be on 15 seconds before H2 is allowed on’).

A special key sequence is provided to return to the *Actual/Setpoint* display mode without first turning the function off. This sequence however, differs slightly between units that contain (16) outputs (vertical Tymkons) and horizontal units that include (32) outputs.

On units with (16) outputs (verticals), functions are normally toggled *On* or *OFF* by hitting a single key '0' through 'F'. To access the *Actual/Setpoint* display mode when a function is already *ON*, simple hit the **MODE** key before hitting the '0' through 'F' key.

On units with (32) outputs (horizontals), functions are normally toggled *On* or *OFF* by entering a two-digit key sequence '0' through '31' and then pressing **ENTER**. To access the *Actual/Setpoint* display mode when a function is already *ON*, simple enter the two-digit sequence and, then, hit the **MODE** key before hitting the **ENTER** key.

Many ***Tymkon*** configurations include latching digital inputs. These inputs may monitor external hardware sensors or they may monitor software conditions as determined by an application-specific safety patch. When a latched input becomes unsafe, the normal method of clearing the latched fault is to press **RESET**. While in *Manual Mode*, however, pressing **RESET** would exit *Manual Mode*. A special key sequence is provided to clear latched inputs without exiting *Manual Mode* - simple hit the **MODE** key before hitting the **CLEAR** key.

5.4. Making a Trial Run (optional)

Note: The following procedure cannot be performed in those ***Tymkon*** configurations in which the *Hold* state has been disabled at the request of the customer.

Having completed programming, the user may step through a trial run to check actual run-time process conditions. This may be accomplished as follows:

5.4.1. Select a recipe as described above.

5.4.2. Press the **RUN/HOLD** pad to enter the **RUN** mode.

5.4.3. Press the **RUN/HOLD** pad once more to enter the **HOLD** mode. The alarm will sound for 1.6 seconds and the alphanumeric display will alternate between the word **HOLD** and the normal recipe, cycle and time format.

5.4.4. While in the **HOLD** mode, observe and confirm the cycle time, gas flow settings and other output conditions for the current cycle.

5.4.5. Press the **STEP** pad to advance to the next cycle.

5.4.6. Repeat the previous two steps until you have checked all of the cycles of the selected recipe.

5.4.7. Having completed the trial run, press **RESET**. This places the ***Tymkon*** back in *Cycle 0 (Idle)* of the selected recipe.

5.5. Making a Process Run

5.5.1. Select a recipe as described above.

5.5.2. Press the **RUN/HOLD** pad to enter the **RUN** mode.

5.5.3. When the run is completed, the alarm will sound at the rate of once per second, and the alphanumeric display will flash **[COMPLETE]**.

5.5.4. The three options now available are:

a.) Press the **ALARM** pad. This will silence the alarm and permit the *Countup Cycle* outputs to remain energized while the *Time-This-Cycle* display continues to count.

b.) Press the **RUN/HOLD** pad to enter the **HOLD** mode, silence the alarm and halt timing. *Countup Cycle* outputs will remain energized.

c.) Press the **RESET** pad to return to the *Idle* (or *Standby*) condition, halt timing, and silence the alarm in preparation for the next process run.

Note: At any time, except while programming, the analog setpoints and the corresponding analog inputs may be read on the alphanumeric display. Just press the pad corresponding to the output to be read.

6. SPECIFICATIONS

The specifications listed below relate to the requirements and capabilities of the components contained in the ***Tymkon*** itself. The requirements of the various sensors and actuators being monitored and controlled must be considered separately.

6.1. Physical

6.1.1. Vertical Cabinet

Dimensions: 10 in. high x 4.57 in. wide x 7 in. deep
Weight: 5 lbs. maximum
Finish: Cardinal, high bake, water-based paint, medium texture.

6.1.2. Vertical Panel Mount

Dimensions: 10 in. high x 5.0 in. wide x 7 in. deep
Weight: 5 lbs. maximum

6.1.3. Horizontal Mount, 32 Output

Dimensions: 4.75 in. high x 18.15 in. wide x 4 in. deep
Weight: 8 lbs. maximum

6.1.4. Horizontal Mount, 16 Output

Dimensions: 4.75 in. high x 15.75 in. wide x 4 in. deep
Weight: 6 lbs. maximum

6.2. AC Power Requirements

Frequency: 50 or 60 Hertz.
Voltage @ 60 Hz: 100 to 125 VAC or 200 to 250 VAC, user specified.
Voltage @ 50 Hz: 110 to 125 VAC or 220 to 250 VAC, user specified.
Power: 25 watts maximum.

6.3. Battery Backup

Type: Ni-Cad.
Rating: 7.2 Volts, 0.450 Amp-Hour or better.
Duration: 3 hours minimum, trickle-charged.

6.4. Microprocessor

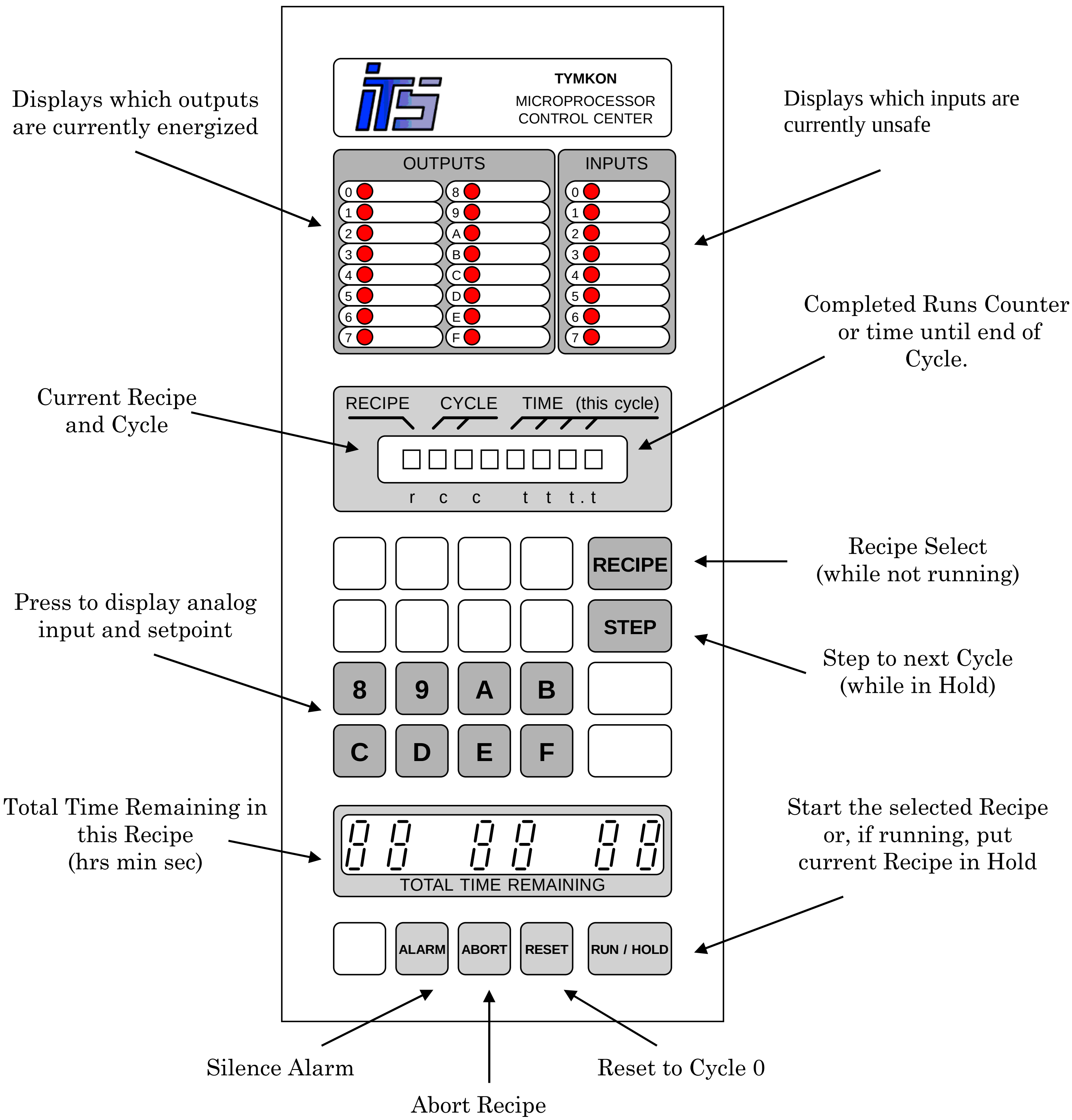
Microprocessor: 8 bit, CMOS, (Harris CDP1805CE).
ROM: (1) 32 kilobyte x 8 bit, CMOS, UV erasable PROM.
NAVRAM: (1) 32 kilobyte x 8 bit, CMOS, static
Mirrored with 32 kilobyte x 8 bit, EEROM.
System Clock: 3.6864 MHz oscillator.

6.5. Timing

Resolution:	0.1 sec.
Accuracy:	determined by accuracy of power line frequency; typically +/- 0.01% short term error, or 3 seconds maximum long term accumulated error; automatically adapts to 50 or 60 Hertz

7. Appendix

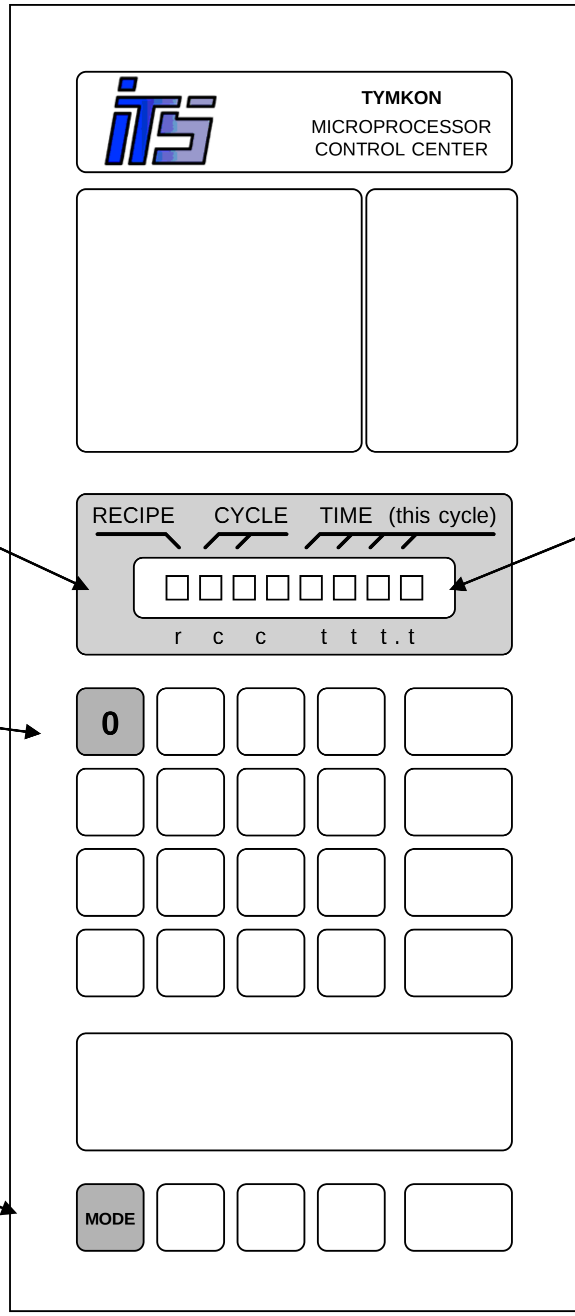
Front Panel Functions during Operation



Mode 0 - Clear Runs Counter

Current Recipe

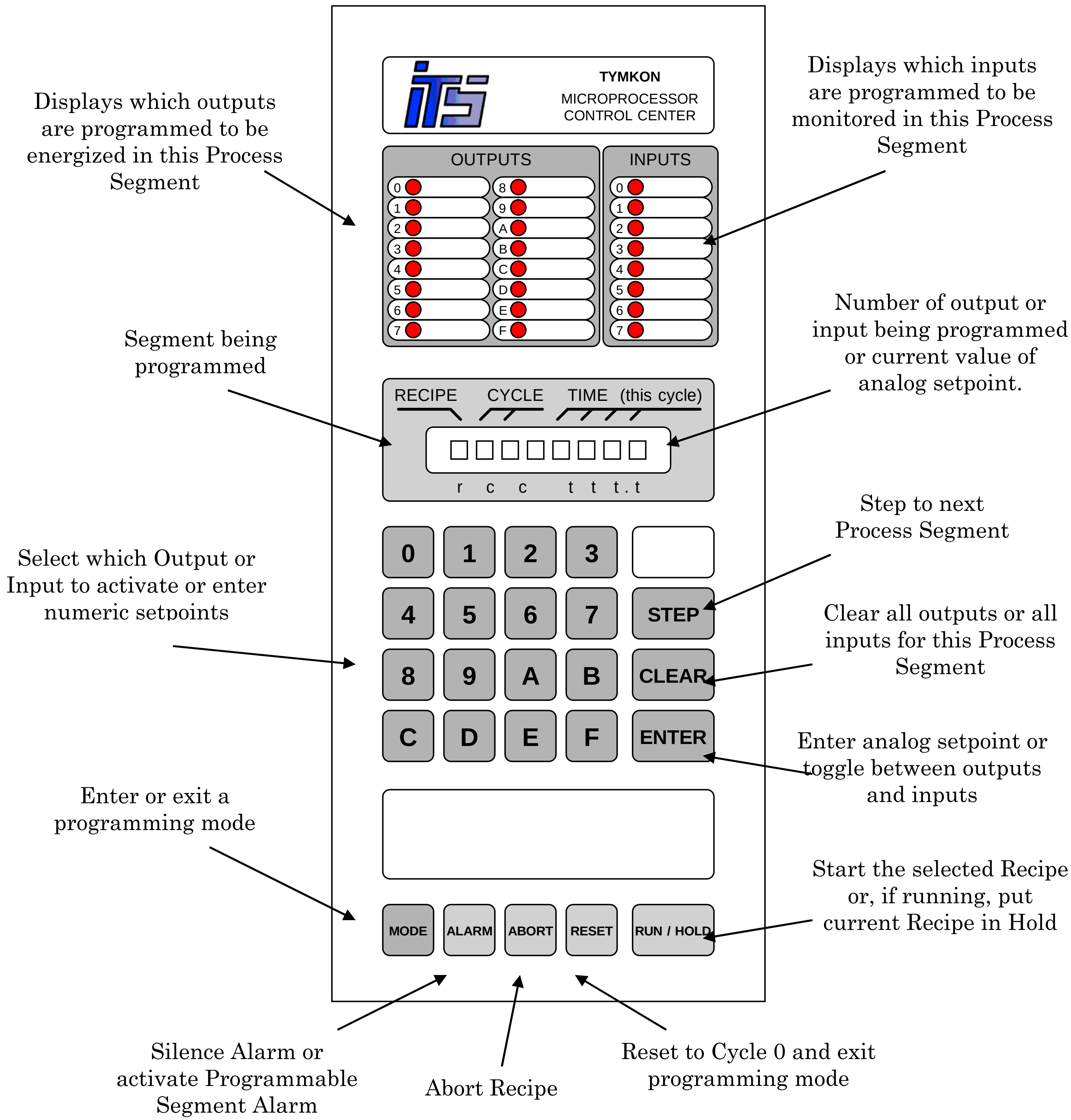
Completed Runs Counter
for current Recipe



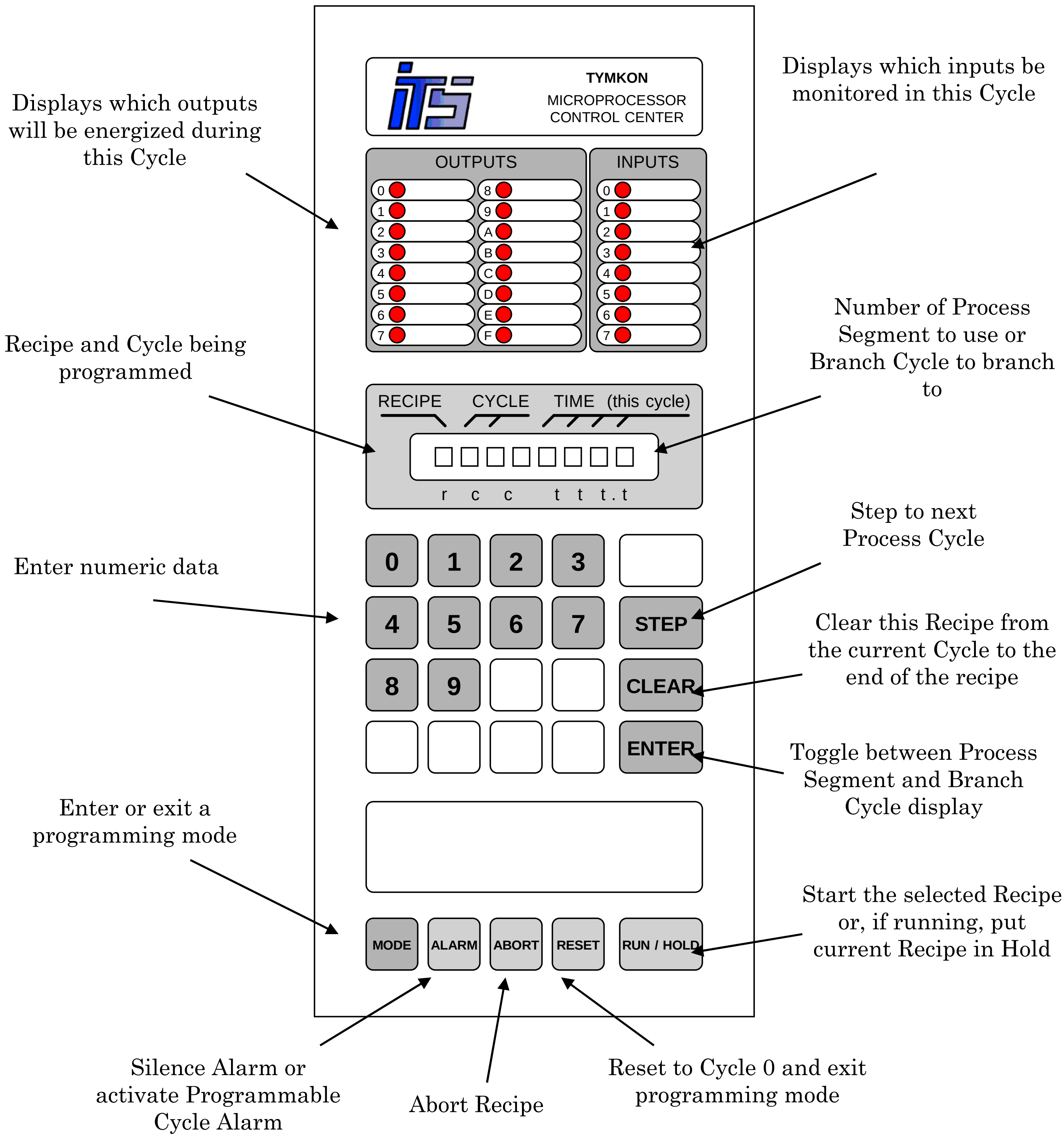
Step 2 – Press to clear Runs Counter for current recipe. If Recipe 0 is selected, clear all Runs Counters.

Step 1 - Press to activate MODE prompt

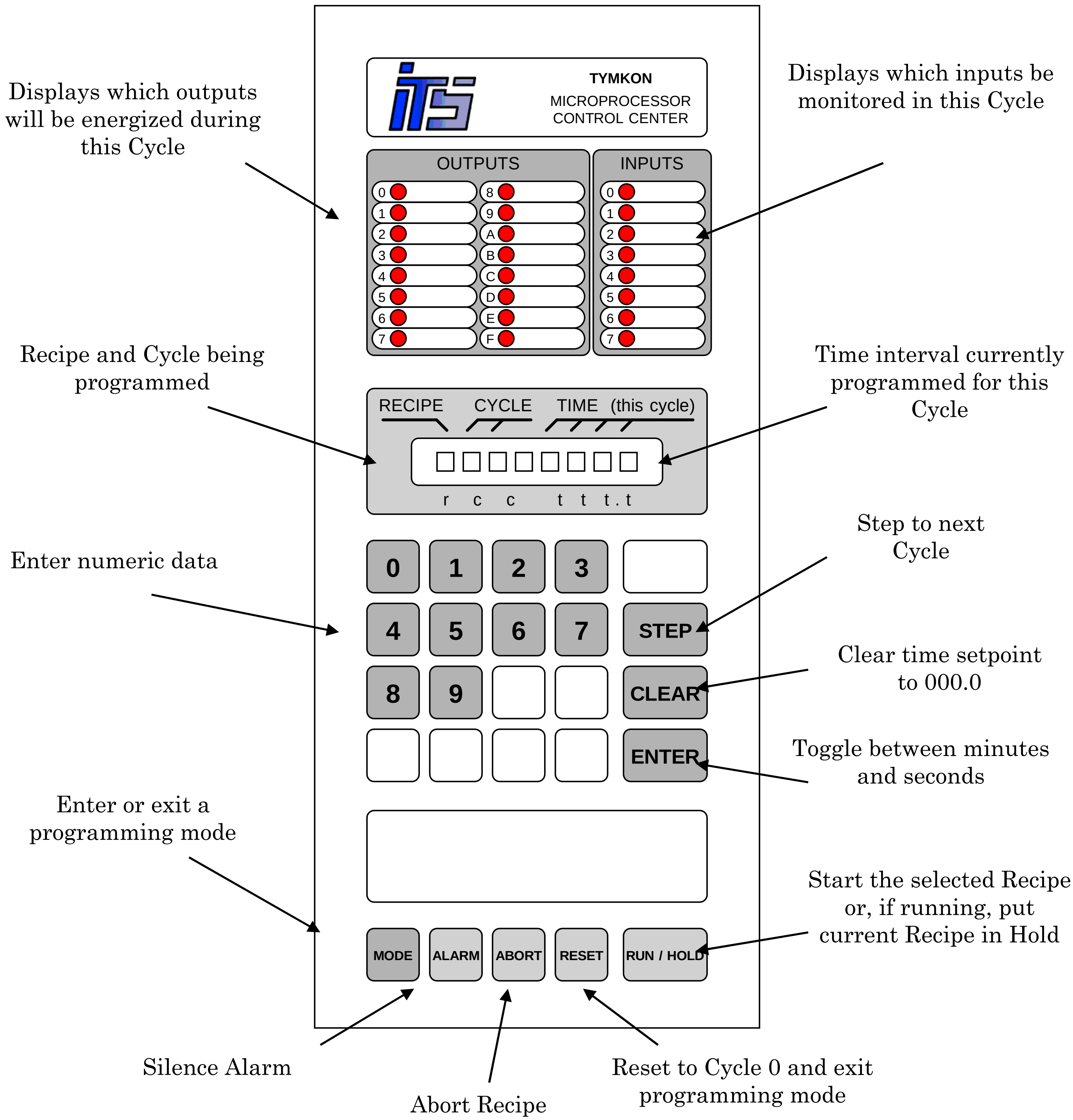
Mode 1 - Define Process Segments



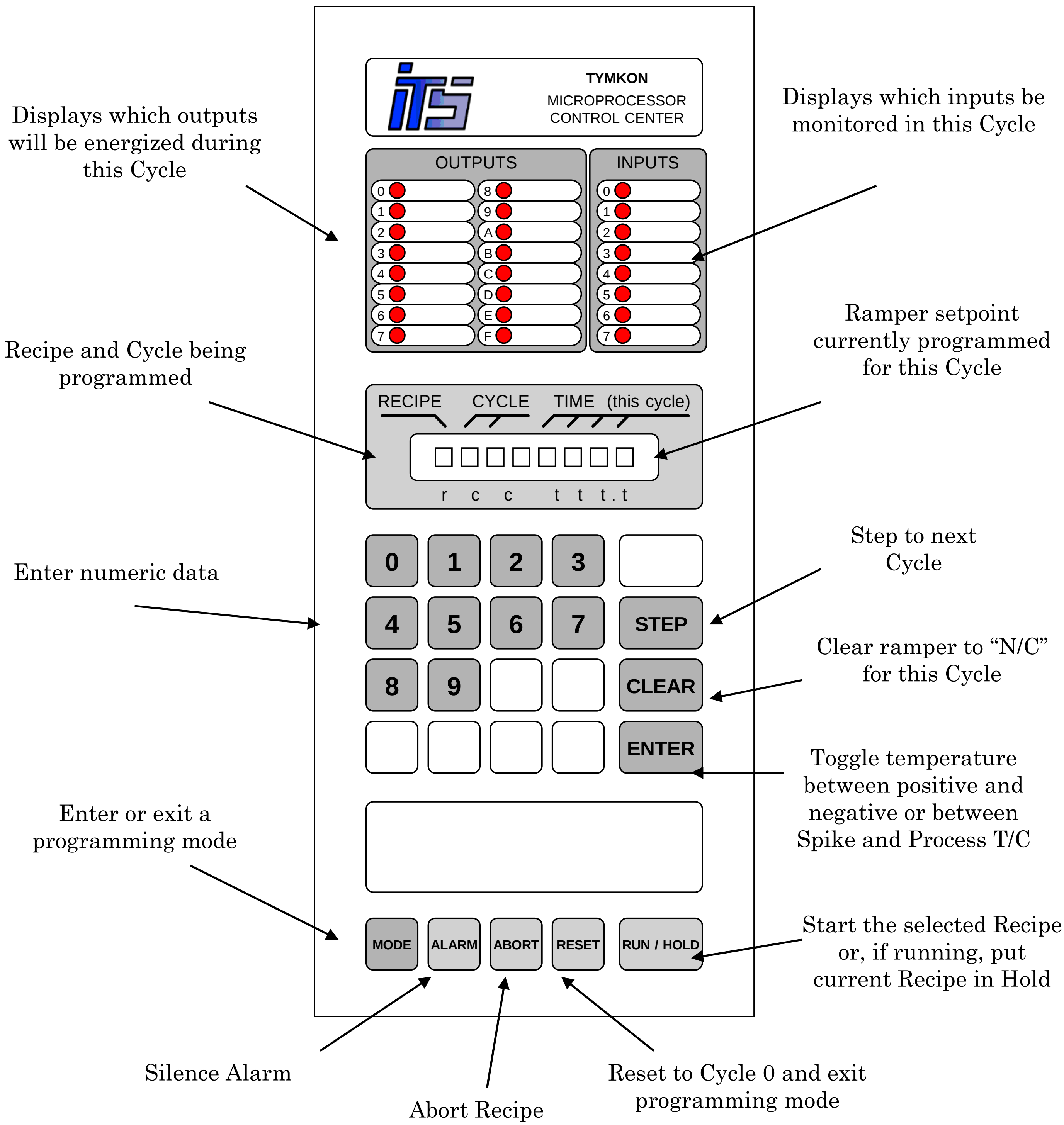
Mode 2 - Construct a Recipe



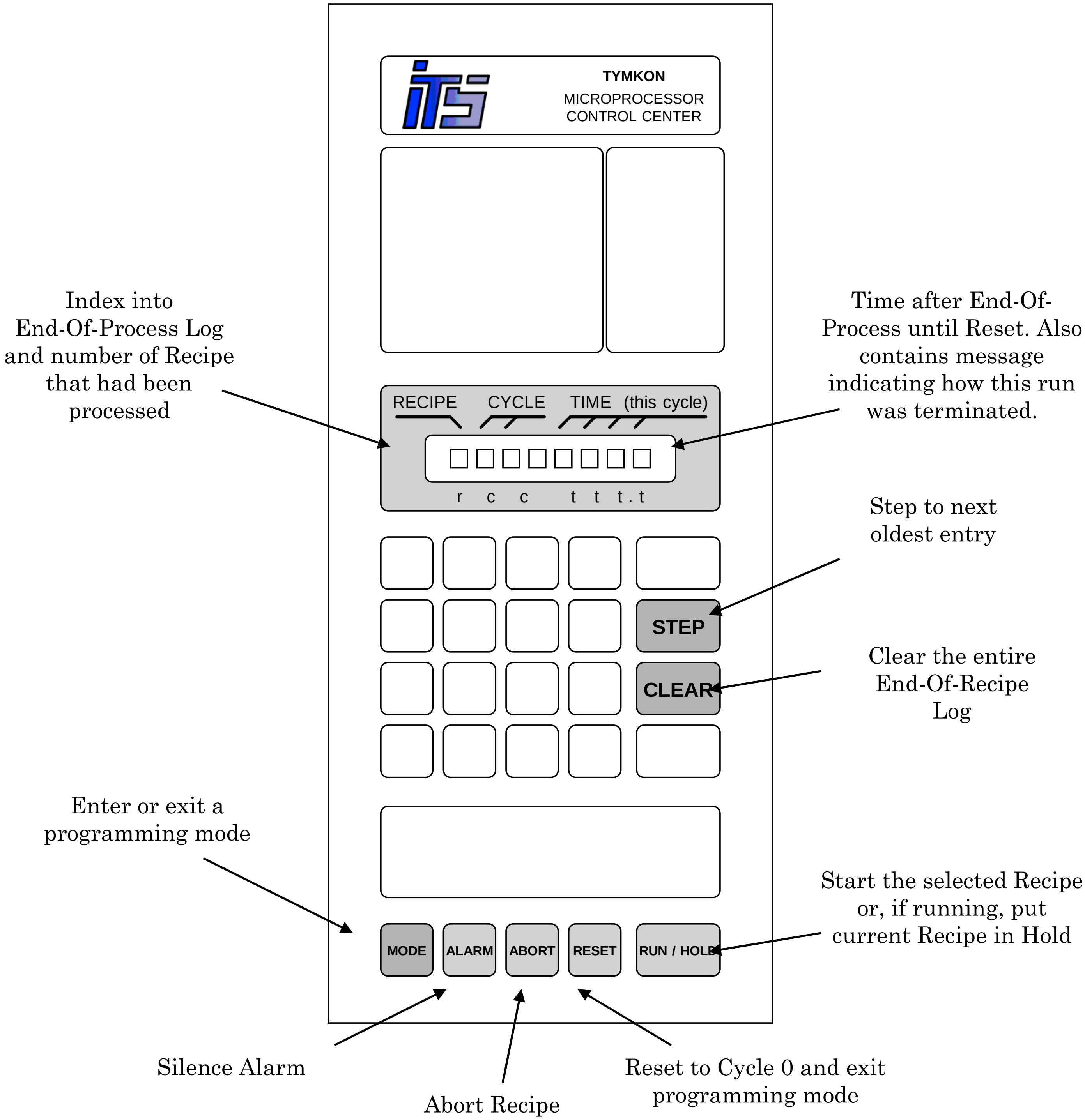
Mode 3 - Assign Cycle Times



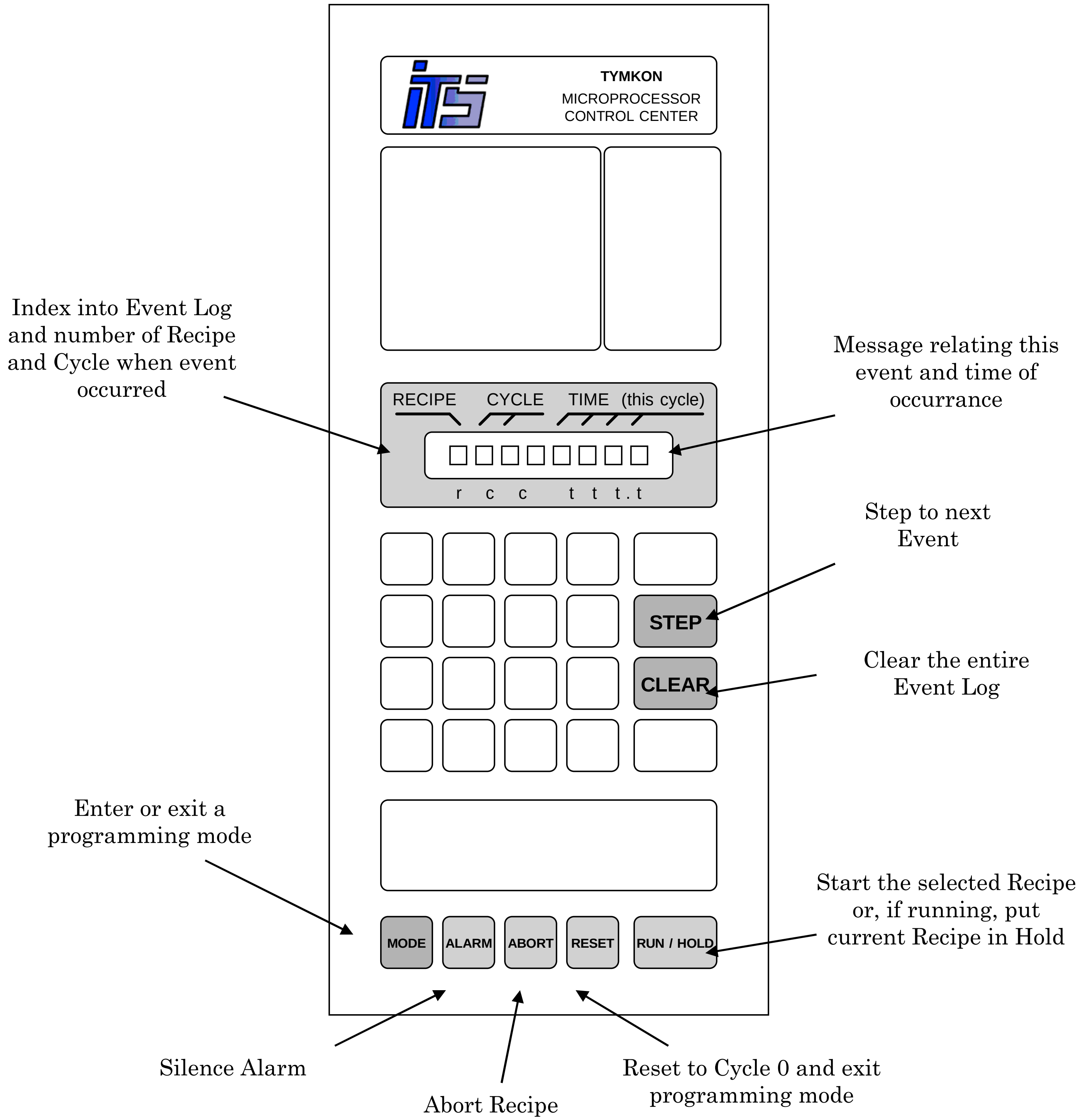
Mode 4 - Enter Temperature Setpoints



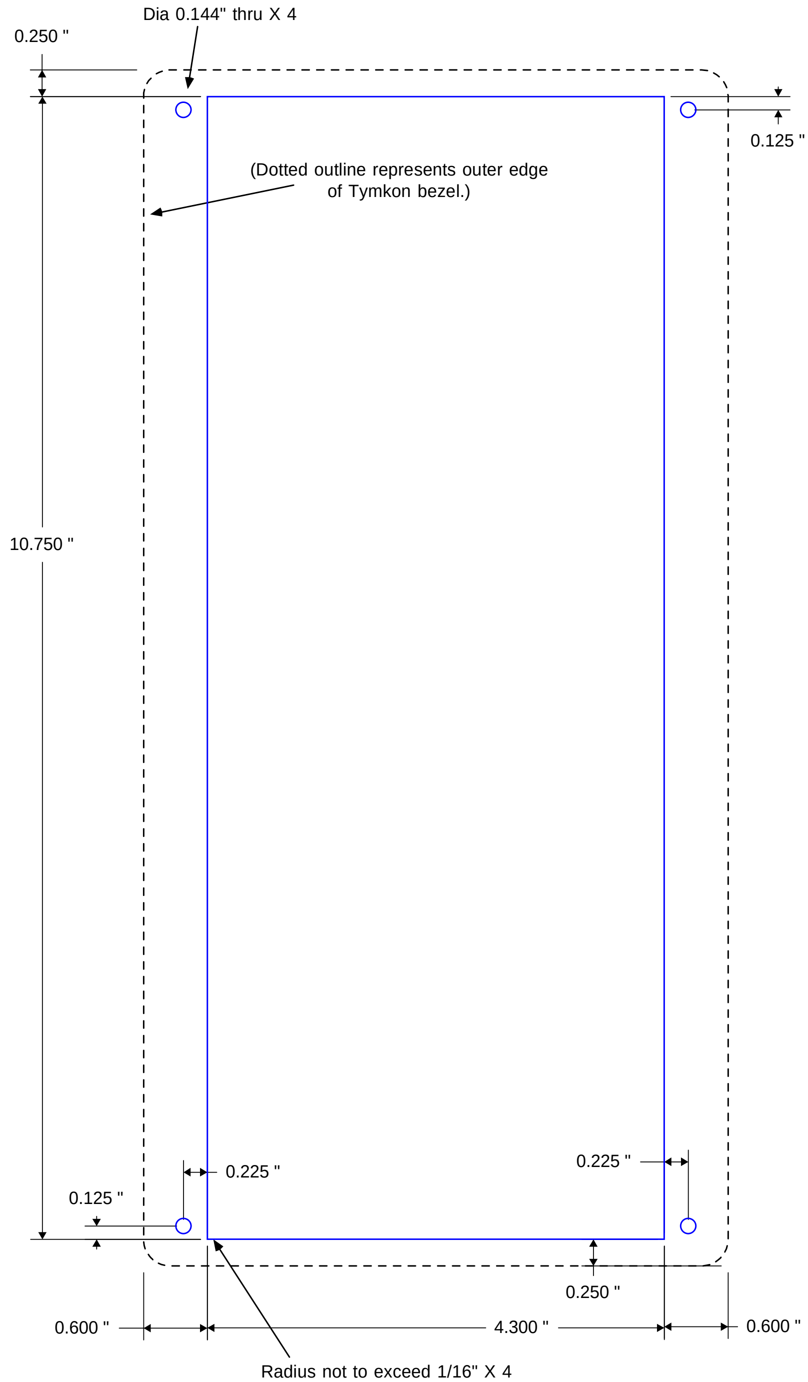
Mode A - Review the End-of-Recipe Log



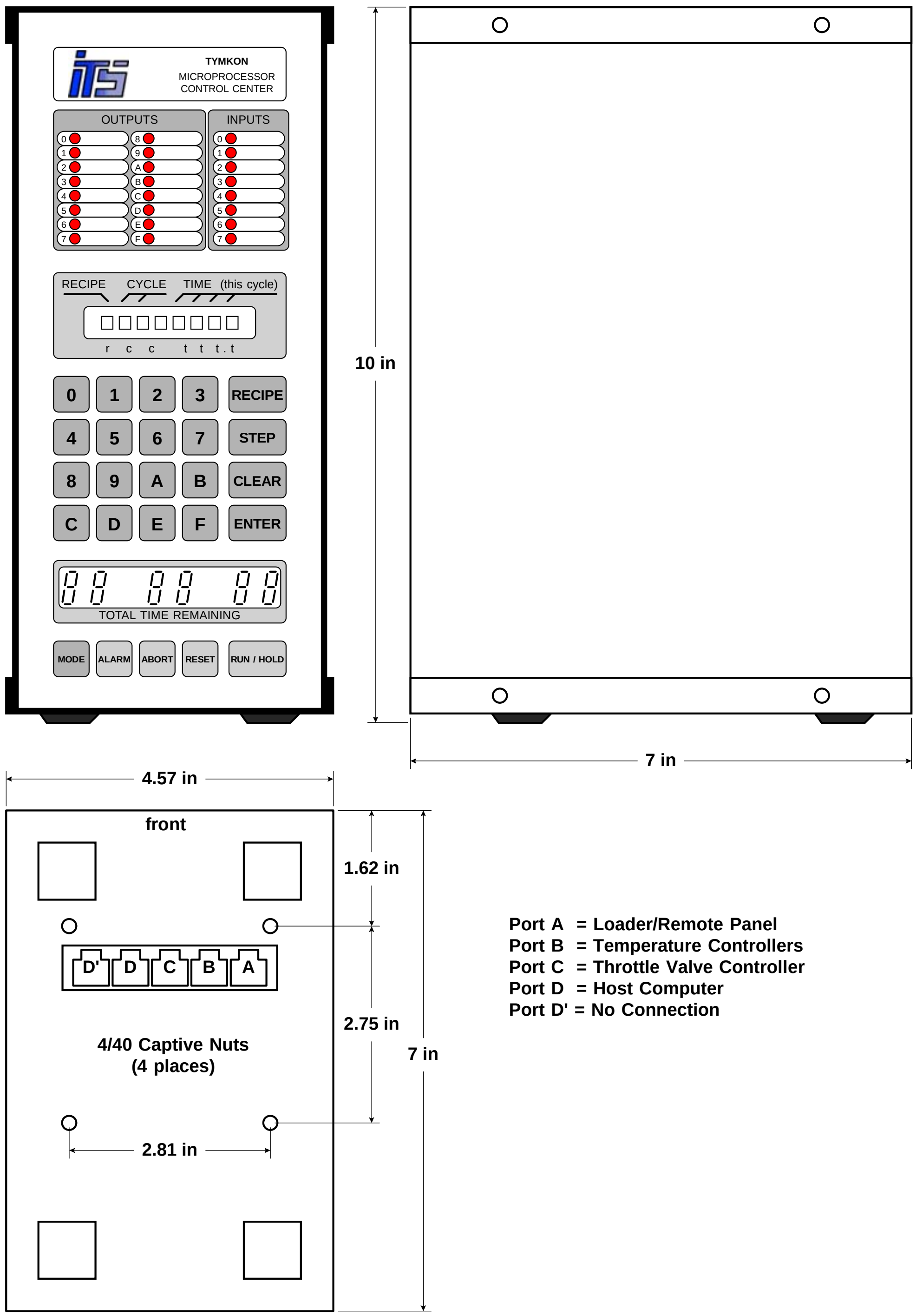
Mode B - Review the Event Log



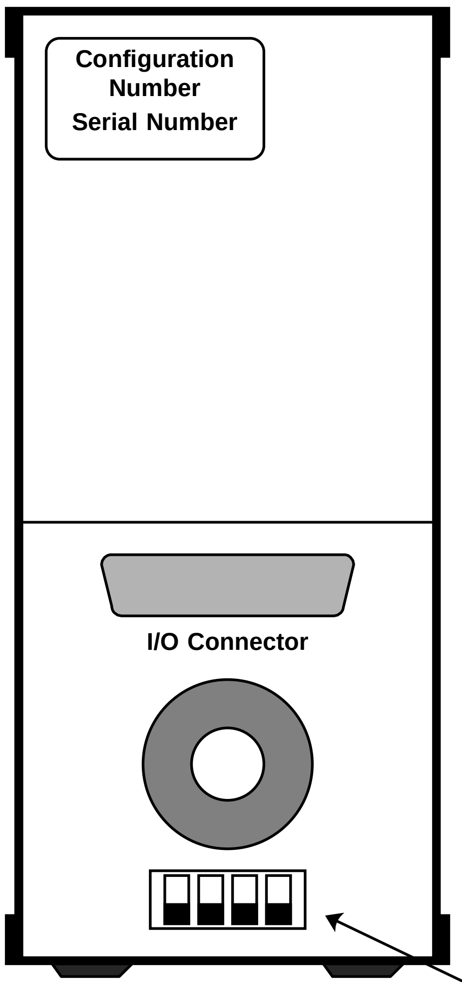
Vertical Panel-Mount Opening



Vertical Cabinet Outline



Rear Panel Switch Functions

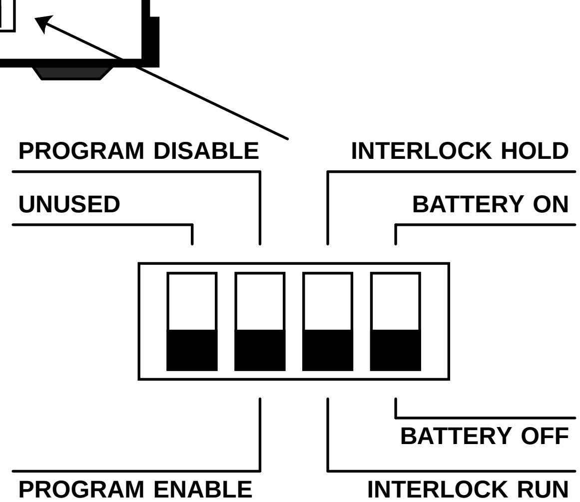


PROGRAM DISABLE / ENABLE
Controls access to programming modes.

INTERLOCK HOLD / RUN
When ON, halts timing during interlock failures.

Note: In some configurations, the 'halts timing' function is permanently enabled and this switch controls some installation-specific option instead.

BATTERY ON / OFF
Connects back-up battery to logic power supply.



Programming Forms

Programming forms are no longer provided in this document. The forms are now available in the Tymkon Recipe Editor, TymEdit. The user may generate their own form as determined by their documentation needs, or they may use TymEdit to document their processes. TymEdit may be used to edit and document recipes whether the Tymkon host software is used to download recipes or the recipes are entered from the Tymkon front panel.