Bailey
network 90®

Distributed Batch Control

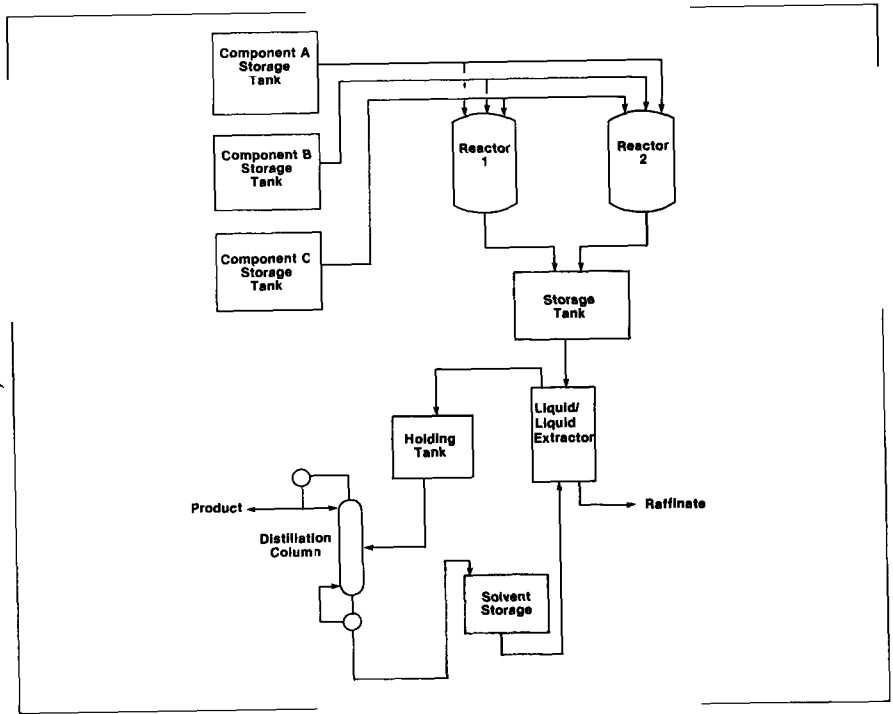


FIGURE 1 Sample Batch Application

Introduction

Bailey Contro s NETWORK 90 s unique y su ted to prov de d str buted contro of batch processes Th s mplementat on gu de uti zes a representative batch process to descr be the concept of distributed batch control and how it s imp emented w th standard NETWORK 90 equ pment

Distributed Batch Control

The basic concept of d str buted batch contro s to perform batch sequenc ng and regu atory contro at the owest possible eve with n a con tro system h erarchy Th s funct onal d stribu tion provides s gn ficant y ncreased re iabi ty super or response t me, and a "gracefu degradat on' fa ure mode unatta nable w th any other control system arch tecture

Application Guide

AG-0000-300-01

Bailey Controls
Babcock & Wilcox, a McDermott company

The bui d ng blocks of a NETWORK 90 d str buted batch contro system aie the standard NETWORK 90 control er modules, og c master modu es, nput/output modu es and CRT operator nterface un t The spec f c capab ties of th s equipment are out ned n the var ous Ba ley Product Specif cat ons

A moderate amount of recipe storage can be accommodated with n the NETWORK 90 Mult Funct on Contro er (MFC) Increased rec pe storage and basic batch documentat on are prov ded by the W nchester d sk based NETWORK 90 Operator nterface Un t (OIU) For app ication ons which requ re archiv ng of batch h story and ong term batch ana ys s (e g the pharmaceutica ndustry), Ba ey s Management Command System (MCS) or ma nframe based 1090 System s ut zed

Conf gurat on of the batch seqL ences for the Bai ey d str buted batch contro system s accompl shed through the NETWORK 90 Operator Interface Un t (O U) Enhanced conf gurat on features are prov ded by the Ba ey Eng neer ng Workstat on (EWS) Management Command System (MCS) and 1090 System

A though a w de range of rec pe storage, batch documentation and conf gurat on capab t es are avai ab e from Ba ey Contro s, the h gher eve capab t es are ncrementa add t ons to the bas c NETWORK 90 d str buted batch control system The batch sequenc ng, regu atory contro and emergency act ons rema n d str buied n the NETWORK 90 system ma nta n ng the funct on a ty and benef ts of a tru y d str buted process contro system

S nce the standard NETWORK 90 equ pment used for batch control s equa y app cab e to cont nuous process contro , fu y d str buted batch and cont nuous contro systems can be designed and mp emented us ng ident ca equ pment These d str buted systems are easi y ntegrated nto a fu ly communicat ng p ant w de NETWORK 90 contro system Further, NETWORK 90 modu e nter commun cat on capab t es a ow batch and cont nuous process contro ers to share the same nformat on w thout externa wir ng Consequent y, costs for insta at on, tra ning (for eng neering, operat on and ma ntenance personne) and spare parts nventor es are m n m zed

Example Application

The concept of d str buted batch contro is best lustrated through an examp e A simple process requir ng batch contro capab lit es is shown n **Figure 1** Reactants are drawn from severa storage tanks nto two batch chemica reactors After the batch reaction s comp ete, the react on products are transferred from the reactors to an ntermed ate storage tank processed through a qu d/ qu d extractor, and then pur fied n a d st lat on co umn This process is characterized by severa interconnected un t operations, a of wh ch must funct on proper y in the proper sequence for the process to operate

Control System Partitioning

To be effect ve a d str buted batch contro system shou d be part t oned to group contro of nterdependent un t operat ons (those wh ch cou d not poss b y operate ndependent y from each other) nto a s ng e contro er modu e Un t opera t ons wh ch can be operated ndependent y from others (at east temporar y) shou d be ocated n separate contro er modu es Th s method of part t on ng max m zes system re abi ty, fau t toler ance and ease of reconf gurat on and ma ntenance (for both the process and contro system) To fur ther nsure contro system integr ty both during fu operat ons and when nd v dua units are out of serv ce, data transfer between modu es should be on a request bas s

Typ ca partit on ng of a d str buted batch con tro system for the examp e app cat on s shown in **Figure 2.** A separate contro er s prov ded for each reactor for reactant d str but on, for qu d/ qu d extract on and for dist ation These control er modu es may be Ba ey Mu t Funct on Contro ers, or any of the other NETWORK 90 contro ers ava ab e

W th the part tioning shown, f the contro system for one of the batch reactors sudden y became noperat ve the rest of the process cou d continue to operate at fu capac ty unt ntermed ate storage was dep eted al ow ng t me for rep acement of the malfunctioning component

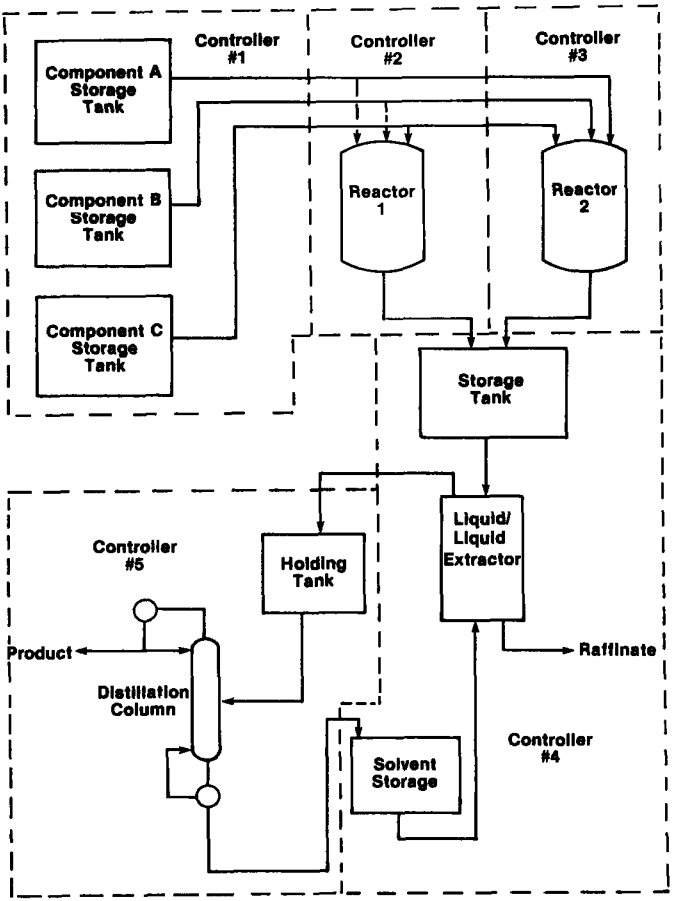


FIGURE 2 Example Control System Partitioning

If a s ng e contro er was used for the ent re pro cess the process wou d be shut down abrupt y, and perhaps not graceful y, and wou d stay shut down unt the ma funct on cou d be d agnosed and corrected As de from the ost product on t me the waste resu t ng from process nterruption wou d be d ff cult and cost y to dea with

Batch Definition

Once the contro system s effect ve y part t oned each of the batch operat ons can be def ned by dent fy ng the dev ces used, the steps requ red for the batch sequence, the rec pe parameters used and the emergency act ons requ red The rema nder of th s gu de w focus on mp ementa t on of d str buted batch contro for one reactor from the examp e app cat on n a Ba ey Mu t Funct on Contro er (MFC)

F rst the dev ces assoc ated w th contro of the batch reactor must be dent f ed These dev ces nc ude ana og measurement sensors, modu at ng contro va ves and d screte dev ces such as motors and on/off va ves D screte dev ce status feedback such as a motor starter ho d ng contact or a valve m t sw tch shou d also be cons dered The ana og and d screte dev ces assoc ated w th the examp e batch reactor are shown n **Figure 3.**

Second, a written descr ption of the batch sequence must be prepared Th s descr pt on shou d break the sequence nto a series of steps and fu y descr be both the act ons taken dur ng each step and the feedback requ red before the sequence can proceed The fo ow ng steps have been def ned
for the examp e batch sequence

Step 1: Clean reactor Open FV4 start M1 and P1, and set T C 2 setpo nt equa to rec pe parameter A Go to Step 2 when reactor s 80% fu

Step 2: Empty reactor Open FV5 When reactor is ess than 5% fu start ten m nute t mer When timer t mers out, go to Step 3

Step 3: Feed component A C ose FV5 and open FV1 Set F C 1 setpo nt equa to rec pe parameter B ntegrate f ow unt tota amount added s greater than the amount nd cated by rec pe parameter C Go to Step 4 when th s s done

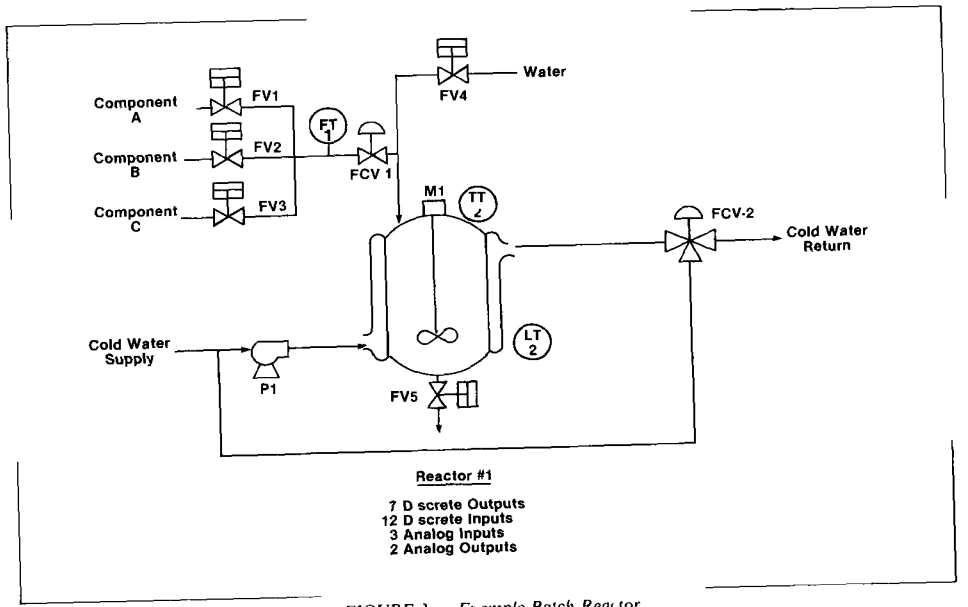


FIGURE 3 Example Batch Reactor

Step 4: Feed component B C ose FV1 and open FV2 Set T C-2 setpoint equa to recipe parameter D Integrate flow unt l tota amount added s greater than the amount indicated by rec pe parameter E Go to Step 5 when th s s done

Step 5: Feed component C C ose FV2 and open FV3 ntegrate f ow unt tota amount added s greater than the amount indicated by rec pe parameter F Go to Step 6 when th s s done

Step 6: Cook reactants C ose FV3 Ramp reactor temperature up to rec pe parameter G at a constant rate When TT 2 s greater than rec pe parameter G go to Step 7

Step 7: Empty reactor Open FV5 When reactor eve is be ow 5%, start 10 m nute timer When t mer t mes out, go to Step 8

Step 8: Cue operator to rev ew and print out batch report After operator acknowledges that he has done this, go to Step 1

Note that th s process is not a continuous batch sequence The process ends in Step 8 and requ res operator nit ation to restart the batch sequence

Th rd, the rec pe parameters must be defined These parameters should be se ected to a ow for variat ons in t me temperature and re at ve amounts of reactants from recipe to rec pe The examp e batch reactor has seven rec pe parameters

Parameter A	Start ng reactor temperature
Parameter B	Addit on rate of components to reactor (setpoint of F C-1)
Parameter C	Amount of component A to add to reactor
Parameter D	Reactor temperature for the addit on of components B and C
Parameter E	Amount of component B to add to reactor
Parameter F	Amount of component C to add to reactor
Parameter G	React on complet on temperature

F nal y the act ons requ red upon dev ce fa ure must be def ned One emergency act on may be defined for any and al dev ce fai ures or a separate emergency action may be def ned for each spec f c dev ce fa ure For the examp e batch reactor, a genera fa lsafe cond tion has been defined for response to any device fa lure

Step 0: Emergency stop P1 and M1 are left running and al va ves are set to the r fa lsafe pos - tion This step s only executed when the operator manua ly n tiates an emergency stop, or the con tro er detects a device fa lure

NETWORK 90 Batch Control Function Blocks

Specia zed batch contro funct on blocks have been deve oped to s mpl fy mp ementat on of d str buted batch control n NETWORK 90 These funct on b ocks w be descr bed n general terms here w th the nterconnect ons shown d agrammat cal y n **Figure 4.**

Device Driver Block (DDB)
The device dr ver b ock (DDB) prov des a means to e ther automat cal y or manua y control and mon tor a d screte control dev ce The DDB nc udes mon tor ng feedback from the device (opened/c osed runn ng, etc) and determ n ng if the dev ce is operating proper y

The general spec f cat ons for a DDB are shown n **Table 1.** Each device dr ver has a boo ean output and a real output The boo ean output s used to dr ve the f e d dev ce through a d screte output channe The rea output goes to the device status mon tor (DSM) block and s used to nd cate f the field dev ce is n the correct state based on the d screte status inputs f the real output has a value of 0 then the fie d dev ce s n the correct state If real output is 1, then the f eld device s not in the proper state f the rea output s 2, the DDB is wait ng for the feedback timer to t me out

The examp e batch reactor has f ve on/off valves, a pump and an ag tator The on/off valves have two mit switches and require a max mum of 5 seconds for ful trave , the actual DDB specif ca t ons of these va ves are shown n **Table 2.** The pump and agitator motors have on y one feedback signa and w l require a maximum of 2 seconds to conf rm operat on, the actual DDB spec f cat ons for one of these dev ces are shown in **Table 3.**

Device Status Monitor (DSM)
A dev ce dr ver b ocks are connected to a dev ce status mon tor (DSM) block The purpose of this block s to monitor the status of the connected device driver b ocks, and report if any one is not operat ng proper y In effect, the DSM block func tions as a spec alized ogica "or" block

The genera specif cations for the DSM b ock are shown in **Table 4.** The rea output from up to s xteen DDB's s fed nto the DSM f any one of

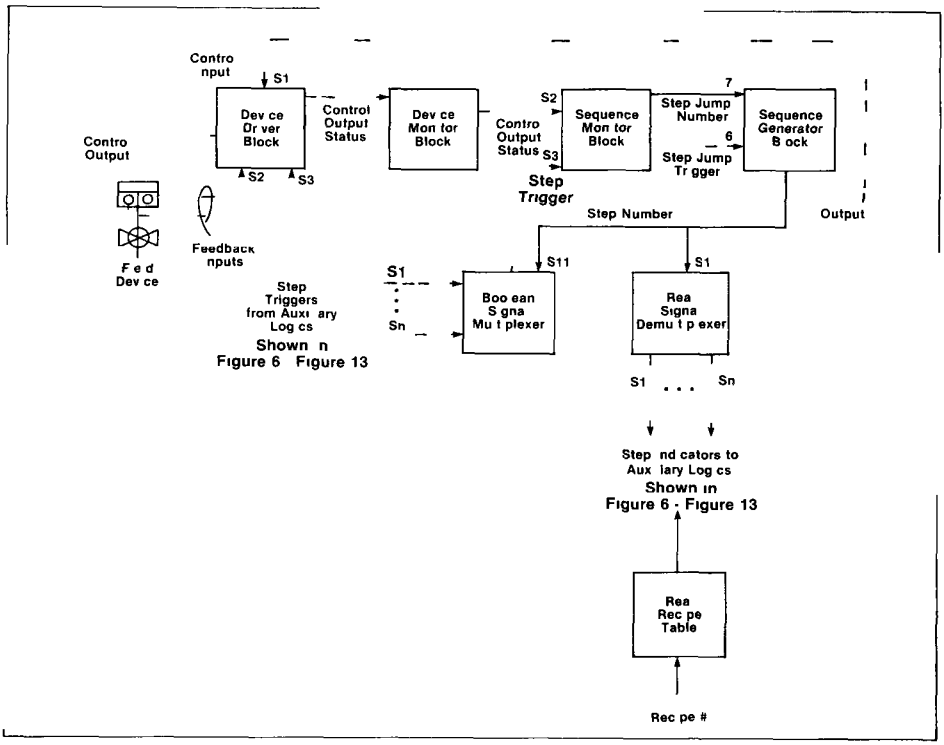


FIGURE 4 Sequence Logic Diagram for Example Batch Reactor

these nputs s 1, then the output (rea) of the DSM s set to 1 f one or more inputs are 2, and the rema nder are 0, then the output w be set to 0 If more than s xteen DDB's must be mon tored the DSM's can be ganged' w th the output of one DSM be ng input to another DSM, just as if t were a DDB

In the samp e batch sequence, a the nputs to the DSM b ock are d rectly from DDB s

Sequence Monitor Block (SMB)

The dev ce status mon tor (DSM) b ock s con nected to a sequence mon tor b ock (SMB) The purpose of the SMB s to determ ne which steps are to be executed and when The SMB wi execute the next norma step once the device status mon tor (DSM) b ock reports that a associated dev ce dr ver b ocks (DDB s) are operat ng norma y and once the step tr gger to the SMB s act vated Shou d a dev ce driver b ock (DDB) nd cate a d screte device ma funct on, the SMB wi execute the spec f ed fault step

The genera spec ficat ons for the SMB are shown n **Table 5.** Each SMB can contro up to e ght sequence steps f more than e ght steps are requ red for a sequence SMB's can be l nked w th the ast step of the first SMB n t al z ng the f rst step of the second SMB Each of the steps is def ned by four bas c spec f cations

1 The next ' norma step to be n tiated when the step trigger s set to 1, but on y if a l the DSM's assoc ated w th the SMB ndicate that al f eld devices are in the r proper state

2 The next ' fau t" step to be init ated f the DSM nd cates that any fie d dev ce is not in its proper state

3 Enable/d sab e the operator step hold ' feature dur ng automat c operation Th s specifica t on w l prevent the operator from ho d ng the sequence n th s step n the case of a tank fil ing step, t would be desirab e to prevent a step hold which cou d cause tank overf ow

4 Enab e/d sab e semi automat c sequence stepp ng Th s spec ficat or wi prevert ho d ng a step for operator acknow edgement wh le n the semi automat c mode

n the samp e batch sequence each next normal step s the next step n sequent a order and al fault steps are Step 0 The actua SMB spec f cat ons for the example batch sequence are shown in **Table 6.**

Sequence Generator Block (SGB)
The sequence mon tor b ock (SMB) ut zes a sequence generato b ock (SGB) to execute discrete outputs and aux iary og c The SGB nc udes an array of up to e ght outputs that can be used to automatica y contro dev ce driver blocks (DDB's) and aux liary og c associated w th each of up to e ght sequence steps

The genera specif cations for an SGB are shown n **Table 7.** For each of e ght steps, there are up to eight d screte outputs wh ch can be spec f ed For sequences onger than eight steps, the SGB s can be ganged by referencing the prev ous SGB n the series For steps requir ng more than eight outputs SGB's can be l nked in para e w th the same step tr gger act vat ng severa SGB s simu taneously

A matr x representat on (mask or truth tab e) of the SGB outputs for each step of the example batch sequence s shown n **Table 8.**

Real Signal Demultiplexer (RSD)
Each step of a batch sequence often requires aux iary og c to perform functions n addit on to act vat ng/deact vat ng discrete dev ces (e g change contro er setpoints, total z ng f ow, etc) As the SGB steps through the batch sequence, the current step number can be read from the SGB step ndicator Th s step number can be used to trigger the aux liary og c with a rea signa demu t p exer (RSD) b ock

The general spec ficat ons for an RSD b ock are shown n **Table 9.** The RSD block has e ght boo ean outputs If the input (rea , from the SGB step indicator) is 1, then the first output s 1 and the other seven are 0 f the input is 2 then the second output is 1, and a l the rest are 0 These boo ean outputs can be used to tr gger execution of spec f c aux liary ogic sequences

Boolean Signal Multiplexer (BSM)
Once the aux l ary ogic has been successfu ly completed, the sequence mon tor block (SMB) step tr gger is activated through a boo ean signa mult p exer (BSM) The general spec ficat ons for the BSM block are shown n **Table 10.** The BSM has one rea nput (from the SGB step nd cator) and ten boo ean inputs (from up to ten aux iary og c comp etion f ags) When the SGB s execut ng step 1 boo ean nput #1 s passed through to the BSM output wh ch is connected to the SMB step tr gger When the SGB is executing step 2, boolean nput #2 s passed through to the SMB step trigger

Real Recipe Table (RRT)
To accommodate different recipes w thin the aux i ary log c, a group of rea rec pe tab e (RRT) b ocks s used to nput the recipe parameter values for an operator se ected recipe The genera specif cations for the RRT b ock are shown n **Table 11.** Each RRT b ock can store up to ten va ues of a spec f c recipe parameter The RRT parameter values are numbered zero through nine When the input to the b ock (rea) is zero then the zeroth parameter va ue is passed through to the b ock output When the nput to the b ock is one, then the f rst parameter va ue is passed through to the output The RRT's can be grouped n para e to provide the requ red number of recipe parameters for a batch recipe The RRT's can also be grouped n ser es when more than ten parameter va ues are required

Example Batch Sequence Logic

A representative sequence logic d agram s shown in **Figure 4,** and aux ary logic d agrams for each step of the examp e batch sequence are shown n **Figure 5** through **Figure 12.** Cross referenc ng between the sequence definit on, the deta led discussion of the funct on b ocks and these diagrams w l prov de a good nd cat on of the flex ib ity ava lab e for imp ement ng d str buted batch control n NETWORK 90 control er modu es The descr pt ons/spec ficat ons for the standard NETWORK 90 funct on b ocks can be found n Bai ey's **Function Code Reference Manual** (Product Instruction E93-900 2)

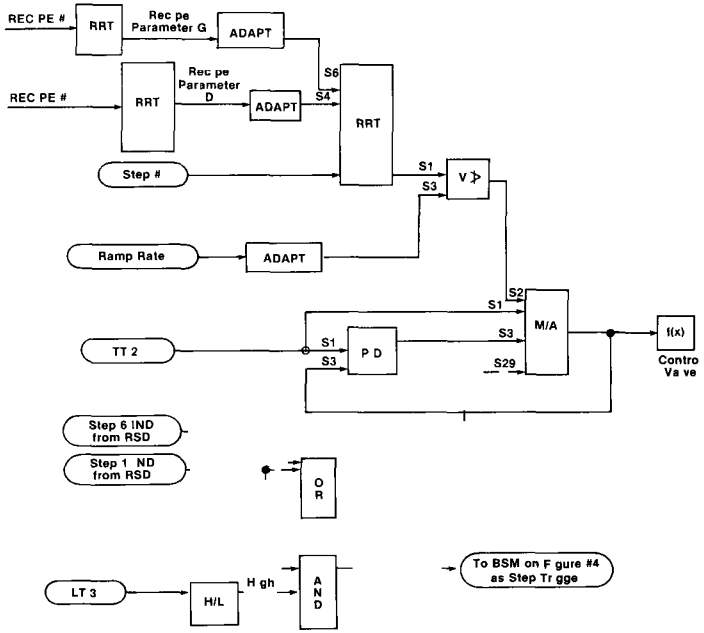
Key for Logic Diagrams

Throughout the examp e logic d agrams, acronyms are placed on function blocks These funct on blocks are documented n the **Bailey Function Code Reference Manual** (Product Instruction E93-900-2)

However, to facil tate reading of the ogic diagrams, the acronym, function code name, and function code number are l sted be ow

Acronym	Name	Function Code
ADAPT	ADAPT	34
AND	AND	37
BSM	Boolean S gna Mu t p exer	119
DDB	Device Driver B ock	123
DMB	Device Mon tor Block	125
DO/L	D g ta Except on Report	45
H/L	H gh/Low A arm	12
M/A	Manua /Auto Stat on	80
NOT	Not	33
OR	Or	39

Acronym	Name	Function Code
P D	P D contro er	18
RRT	Rea Rec pe Tab e	118
RSD	Real S gnal Demu t p exer	126
RMSC	Remote Manua Set Constant	6 8
SGB	Sequence Generator B ock	161
SMB	*Sequence Mon tor B ock*	*124*
T	Transfer Ana oç	9
TD DIG	T me De ay D g ta	35
V	Rate L m ter	8
∫	P D contro er w thout P and D	18



Step 1: Clean reactor Open FV4, start M1 and P1, and set TIC 2 setpoint equal to rec pe parameter A Go to Step 2 when reactor s 80% ful

FIGURE 5 Step #1 Auxiliary Logic

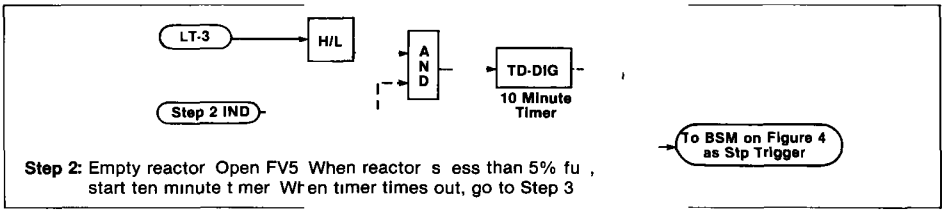


FIGURE 6 Step #2 Auxiliary Logic

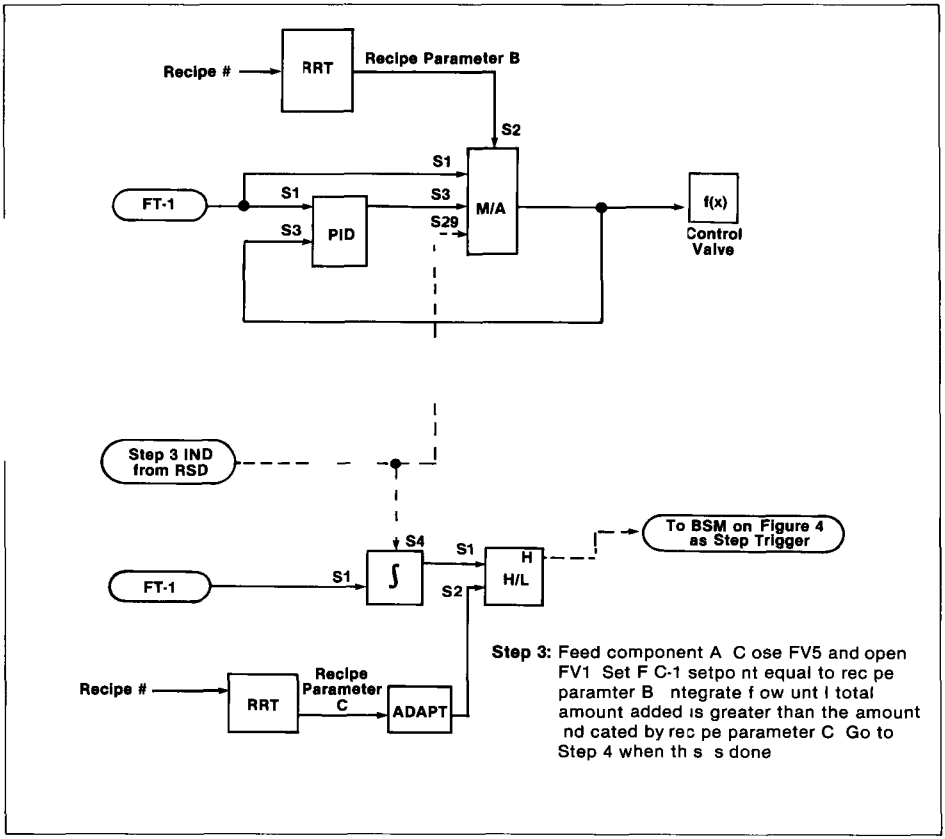


FIGURE 7 Step #3 Auxiliary Logic

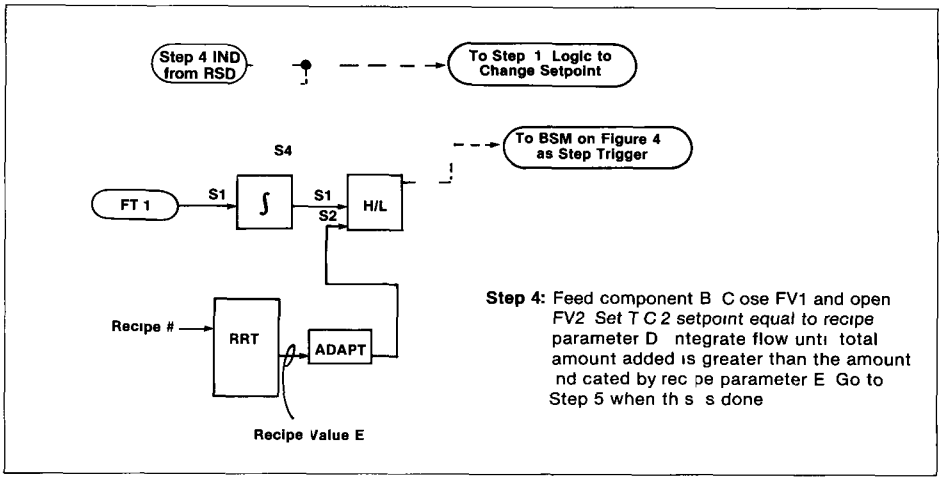


FIGURE 8 Step #4 Auxiliary Logic

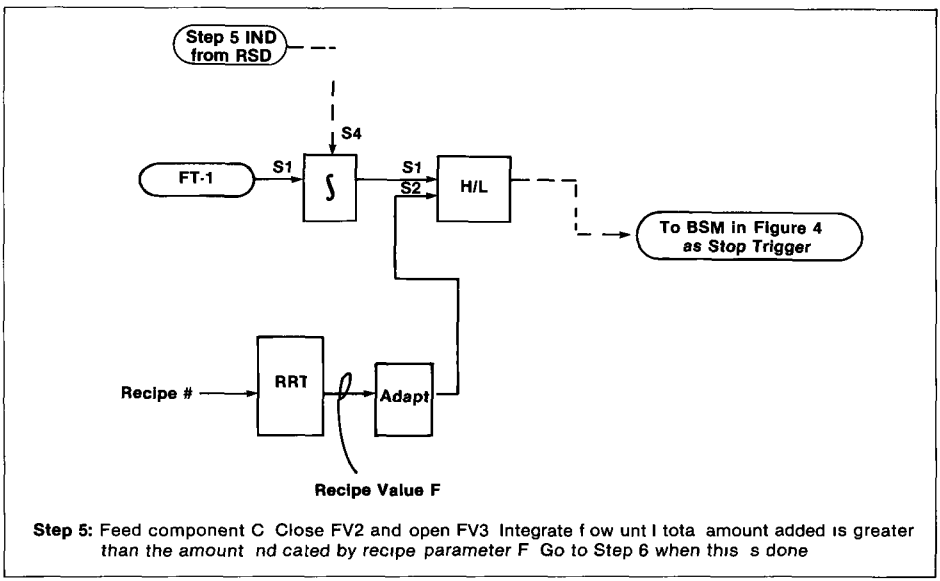


FIGURE 9 Step #5 Auxiliary Logic

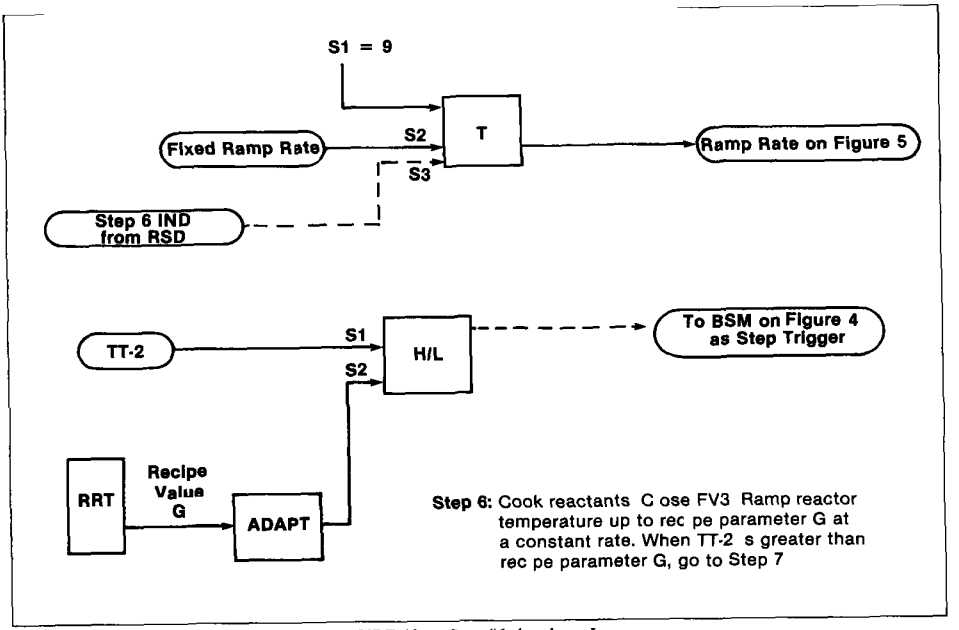


FIGURE 10 Step #6 Auxiliary Logic

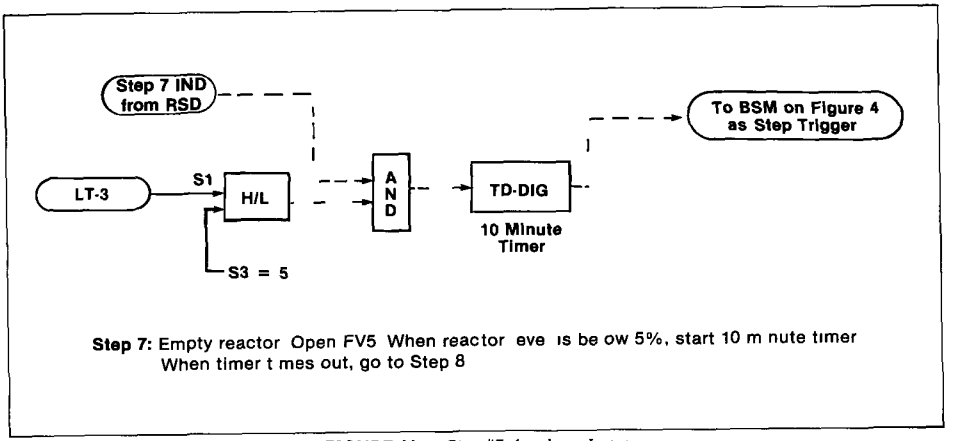


FIGURE 11 Step #7 Auxiliary Logic

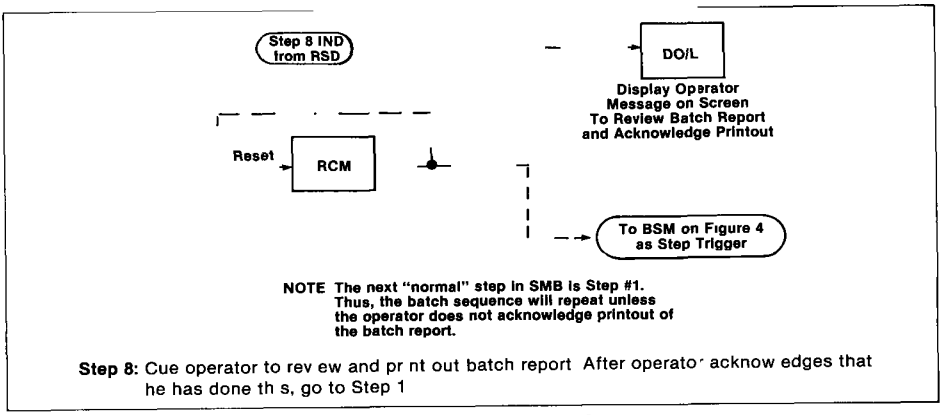


FIGURE 12 Step #8 Auxiliary Logic

Operator Interface

Effect ve operator nterface s cr tica to effect ve batch contro An overv ew graphic d sp ay should diagrammat ca y represent the batch process and nd cate the current step of the batch sequence The operator shou d be provided w th the capab ty to manua ly ntervene and sem automat ca y step through the sequence He shou d a so be pro v ded with the faci ty for mod fy ng rec pes on ne

Process Graphic Display

A representat ve process graph c disp ay for the examp e batch reactor is shown in **Figure 13.** Th s s an act ve graph c d sp ay wh ch nd cates the status of a l d screte contro dev ces and the cur rent sequence step through changes n co or Th s d sp ay a so prov des the operator with the capab ty to start an automat c batch sequence, stop the sequence, manua y advance to the next step n the sequence and manua y act vate any dev ce in the contro system

The control er modu e og c requ red to a ow the operator to manua y intervene during a batch sequence s shown n **Figure 14.** Th s scheme a ows the operator to put the sequence n a ho d state, change the step number and then start the sequence at the new step number If the ho d feature s d sab ed for the current step dur ng conf guration of the sequence mon tor b ock (SMB), when the operator in t ates a sequence ho d, the step w run to comp etion and then the sequence w l stop If operator ntervent on n the sequence must be periodica y nh b t ed, a manual switch b ock can be added to set the nonperm ss ve f ag for the remote contro manua (RCM) block that starts and stops the sequencer, th s b ock can be changed with the O U in the tuning mode

Recipe Editing Graphic Display

A representat ve graph c d sp ay for rec pe ed ting s shown n **Figure 15.** The operator s mp y adds the rec pe number to be changed and the va ues of the var ous rec pe parameters Once the va ues have been ver f ed by the operator, the rec pe s down oaded to the batch contro er by act vating the ' rec pe update" button The contro er modu e og c requ red to a ow the operator to change the batch rec pe(s) s shown n **Figure 16**

Batch Documentation

An examp e of the type of batch documentat on wh ch can be generated by a distr buted batch contro syste s show r **Figure 17.** Data o batch tota s, step start/stop t mes, out of m t a arms, and any other parameters of nterest are stored n the batch control er modu e Th s nfor mat on s accessed by the graph c disp ay n the Operator nterface Un t (O U) If for any reason the OIU becomes noperat ve, the data w l not be ost

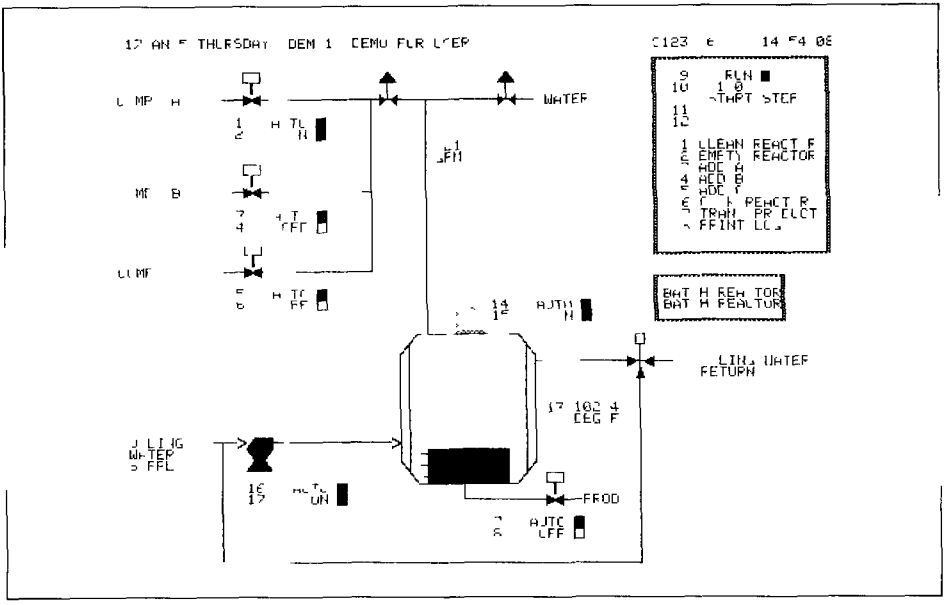


FIGURE 13 Sample Process Graphic Display

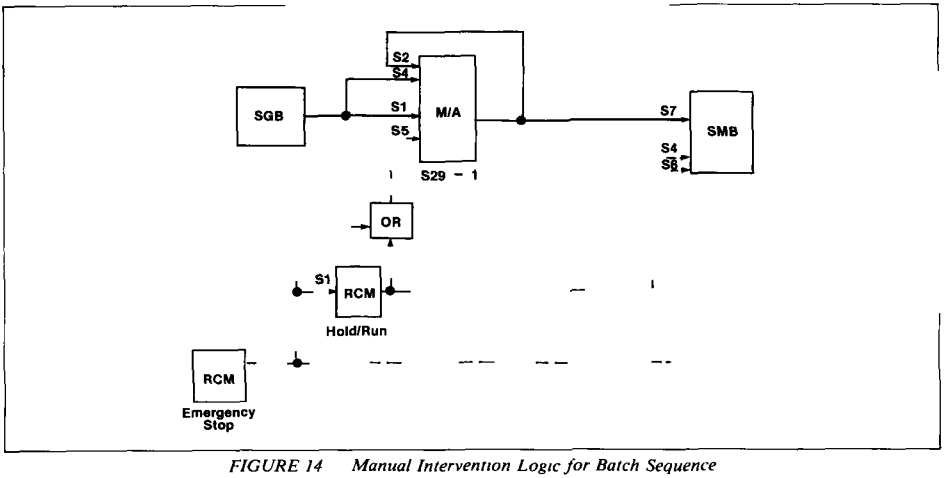


FIGURE 14 Manual Intervention Logic for Batch Sequence

1 ANS5 THURSCH RTT M C FE IFL F GE 5123 E 14 53 04

F CIFF I 1HLF 1

ACTIFI 14 N IE

DESCRIPTION	EXISTING VALUE	NEW VALUE
SOLVENT TO ADD	[illegible] GAL	1 5[illegible]0 GAL
TMA TC ADC	[illegible] GAL	2 294 GAL
AMA D T ACD	[illegible] GAL	3 400 GAL
N BULI TO ADD	[illegible] GAL	4 300 GAL
OXYGEN TO ADD	50M [illegible] FT	5 275 CU FT
ATER [illegible] ACC	3MM [illegible]	[illegible] 7MA [illegible]
COOK TEMP	10M F	7 115 F
COOK TIME	25 MIN	8 30 MIN
RAMP RATE	1 [illegible] F MIN	9 1 1 F MIN
COOLDOWN RATE	8 [illegible] F/MIN	10 5 0 F/MIN
AGITATION SPEED	3M RPM	11 40 RPM
N B LI ADD RATE	22 GPM	12 0 GPM

FIGURE 15 Sample Batch Recipe Editing Graphic

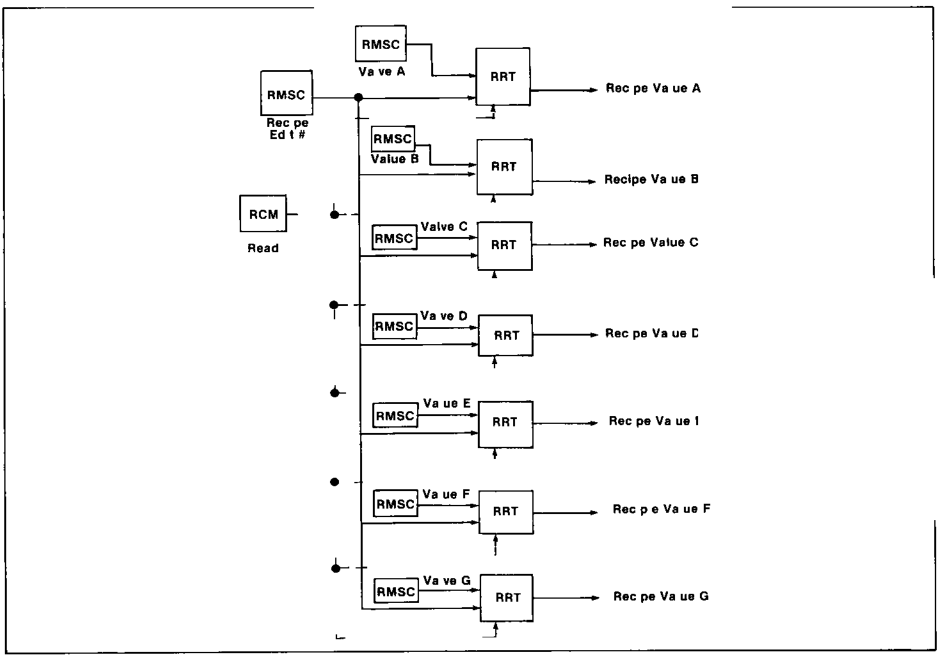


FIGURE 16 On Line Recipe Editing Logic

```
17JAN85 THURSDAY  DCCUMT BATCH RECORD                    S123  6     14 55 26
                          BATCH RECORD

   BATCH NUMBER     514
      START TIME   1121
      END TIME     1315

   RECIPE NUMBER    29

        MPONENT      TARGET VALUE    ACTUAL    MISCELLANEOUS

      SOLVENT          80 GAL       685 GAL
      TMH              200 GAL      247 GAL   MAX TEMP      =  117 F
      CHMH D           150 GAL      154 GAL
      N BUTI           225 GAL      226 GAL   ADD  FLOW RATE     22 GPM
      OXYGEN           800 CU FT    389 CU FT
      WATER            700 GAL      342 GAL

      CONDITIONS

      C OK TEMP IN STEP #4                 110 F
       CUK TIME IN STEP #4                  25 MIN
      RAMP RATE IN STEP #6                 1 5 F MIN
      COOLDOWN RATE IN STEP #8             2 7 F/MIN
      AGITATION SPEED IN STEP #11           30 RPM
```

FIGURE 17 Sample Batch Record

FUNCTION CODE 123

DEVICE DRIVER BLOCK

Description

The Device Driver funct on code nterfaces the control system to a rea fie d dev ce t prov des contro to and accepts feedback from ts ass gned dev ce t receives a Contro nput from the sequenc ng og c and sets ts Contro Output equa to ts Control nput Th s Contro Output s then suppl ed to ts assoc ated rea dev ce

The Dev ce Dr ver a so accepts e ther 1 or 2 Feedback nputs from the f e d (S2 & S3) which def ne the actua state of the dev ce The Feedback Status Masks (S7 & S8) def ne the "Normal" states of the Feedback Inputs correspond ng to a Contro Output of 0 (S7) and to a Contro Output of 1 (S8)

The Contro Output Status represents the status of the assoc ated Rea Device The Con trol Output Status is 'GOOD (0 0) when the Feedback Wa t ng T me (e g va ve stroke t me) has e apsed and the Feedback nputs from the f eld are equa to the corresponding 'Norma " Feedback Status Mask The Contro Output Status s 'BAD" (1 0) when the Feedback Wa ting T me has e apsed and the Feedback Inputs from the f eld a e not equa to the cor respond ng "Norma ' Feedback Status Mask The Contro Output Status s WA TING (2 0) when the Feedback Wa t ng T me has not e apsed

The Contro Output Status can be overr dden by sett ng the b ock address n S4 1 Th s wou d be done when a dev ce fa ure (such as a bad mit sw tch) caused the DDB to ndicate a bad status and the operator wanted to overr de th s fa lure to proceed w th a sequence

The contro output s norma y set to the state the b ock address in S1 s n However f S5 1 then the funct on b ock w l pass the boo ean va ue read in from S6 to the output

The Dev ce Dr ver generates an except on report s m ar to that of a Remote Control Memory (RCM function code #62) The Dev ce Driver except on report conta ns a one or a zero (indicat ng ts output) and an a arm (ind cat ng whether the feedbacks confirm that the dev ce s work ng correct y) The Dev ce Dr ver can be g ven a tag (n OIU rev s on L or ater) and th s tag can be used n e ther group or graph c d sp ays Com mon y, the tag s used to change colors of dynam c symbo s for nd cat ng dev ce status to operators

OUTPUTS (Function Code 123)

Block No	Data Type	Description
N	Boo ean	Contro Output
N+1	Rea	Contro Output Status (0 0 Good 1 0 Bad 2 0 Wa t ng)

SPECIFICATIONS (Function Code 123)

Spec No	Tune	Default Va ue	Data Type	Range Min	Range Max	Descript on
S1	No	0	2	0	2047	B ock Address of Contro nput
S2	No	0	2	0	2047	B ock Address of Feedback nput #1
S3	No	0	2	0	2047	B ock Address of Feedback nput #2
S4	Yes	0	1	0	1	Contro Output Status Overr de
S5	No	1	2	0	2047	B ock Address of Output Overr de Perm ss ve
S6	No	0	2	0	2047	B ock Address of Overr de Output
S7	Yes	0	1	0	2047	Feedback Status Mask Output 0
S8	Yes	0	1	0	2047	Feedback Status Mask Output 1
S9	Yes	0 0	R3	0	Fu	Feedback Wa t ng T me (Seconds)
S10	No	0	1	0	255	Dev ce Dr ver D sp ay Type

TABLE 1 Device Driver Block Description

BLOCK DETAILS

DEVICE DRIVER			CODE - 123 PCU41 MOD3 BLK 50
S1	201	2	Block Address of Contro Input
S2	545	I2	B ock Address of Feedback nput #1
S3	546	I2	B ock Address of Feedback nput #2
S4	0	1	Contro Output Status Overr de
S5	1	I2	Block Address of Output Override Permissive
S6	0	I2	B ock Address Overr de Output Status
S7	01	1	Feedback Status Mast Output 1
S8	10	I1	Feedback Status Mask Output 0
S9	5	R3	Feedback Waiting T me Seconds
S10	0	I1	Device Driver D sp ay Type

TABLE 2 Example Device Driver Specifications (On/Off) Valve

BLOCK DETAILS

DEVICE DRIVER			CODE — 123 PCU41 MOD3 BLK 50
S1	202	2	B ock Address of Contro Input
S2	547	I2	Block Address of Feedback Input #1
S3	0	I2	B ock Address of Feedback nput #2
S4	0	1	Contro Output Status Overr de
S5	1	2	B ock Address of Output Overr de Permissive
S6	0	I2	B ock Address Overr de Output Status
S7	10	1	Feedback Status Mask Output 1
S8	00	1	Feedback Status Mask Output 0
S9	2	R3	Feedback Wa t ng T me Seconds
S10	0	1	Dev ce Dr ver D sp ay Type

TABLE 3 Example Device Driver Specifications (Motor)

FUNCTION CODE 125

DEVICE MONITOR BLOCK

Description

The Dev ce Mon tor B ock funct on code inks together up to 16 Device Drivers Funct on Code 123) or Dev ce Monitor B ocks to prov de a common contro output status output W1en a l nputs are good (0 0) the output s good (0 0) When any nput is BAD (1 0) the output s 3AD (1 0) When any nput s waiting (2 0), and no nput s BAD (1 0), then the output is wait ng (2 0)

OUTPUTS (Function Code 125)

Block No.	Data Type	Description
N	Rea	Contro Output Status (0 0 Good 1 0 Ead 2 0 Wa t ng)

SPECIFICATIONS (Function Code 125)

Spec No	Tune	Defau t Value	Data Type	Range Min	Range Max	Description
S1	No	5	2	0	2047	B ock Address of Contro Output Status #1
•						
•						
•						
S16	No	5	2	0	2047	B ock Address of Contro Output Status #16

TABLE 4 Device Monitor Block Description

FUNCTION CODE 124

SEQUENCE MONITOR

Description

The Sequence Monitor funct on b ock controls the execut on of an assoc ated Sequence Generator function block (Funct on Code 161) Each step w th n the sequence has two assoc ated step numbers to which t can pro ceed One represents the step number of the 'Fau t' step The sequence proceeds to th s step, if, at any time, the Contro Status nput (S2) is BAD (1 0) The other represents the step number of the ' NORMAL' step The manner n wh ch the sequence proceeds from an ex st ng step to ts associated 'NORMAL ' step depends on the STEP TYPE ' (S9) of the ex st ng step ' STEP TYPE ' (S9) s a two d g t number f the second d g t s a 0 the sequence will proceed to the next step when both the Contro Status nput (S2) s "GOOD' (0) and the Step Tr gger (S3) s on (1) f the second d g t s a 1, the sequence w proceed to the next step when the Contro Status nput (S2) s ' GOOD" (0) f the second d git s a 2, then the sequence w proceed to the next step when the step tr gger s on (the contro status nput s ignored)

The sequence w l proceed as descr bed above when the Sequence Mon tor s n the ' Automatic ' mode (S8) When the Sequence Mon tor s p aced in the ' Sem Automat c ' mode the operator s nd rect y tak ng manua contro of the sequence As ment oned prev ous y, 'STEP TYPE' (S9) is a two dig t number w th the second dig t a ready having been addressed f the f rst dig t s e ther a 0 or 1, 'manua ' contro s permitted The operation of the Sequence Mon tor can then be summar zed as fo ows

1 If the Sequence Monitor s n ' Automat c ' (S8 1) the sequence proceeds as descr bed n the preced ng paragraph

TABLE 5 Sequence Monitor Description

2 f the Sequence Monitor s n "Sem - Automat c ' (S8 = 0) the sequence proceeds from one step to the ' Norma " step by operator act vation of the ' Sem -Automat c Trigger' (S5), except n those cases where the f rst d g t of the 'Step Type' (S9) is a 2 For those steps the sequence proceeds as f n the "Automat c" mode

The Sequence Monitor can also be he d at certa n steps, specif ca y those steps whose first d g t of its STEP TYPE" (S9) s a 0 The HOLD ' on the Sequence Mon tor s activated through the "HOLD/INITIAL ZE' sw tch (S4), the Sequence Monitor proceeds to the "Initia Step Number (S7) when S4 goes from 1 to 0

The "Emergency Stop ' spec fica on (S6) w l drive the SGB to step 0 (the reset step) whenever function at the b ock address n S6 has a va ue of 1 Th s s norma ly a RCM b ock (funct on code 62) that is set up as a "panic' button.

Each Sequence Mon tor can hand e eight individua steps Sequence Mon tors can be chained together in a ser es fash on through the use of Spec fica on #1

OUTPUTS (Function Code 124)

Block No.	Data Type	Description
N	Rea	Jump Step Number
N + 1	Boo ean	Jump Step Trigger

SPECIFICATIONS (Function Code 124)

Spec No.	Tune	Default Value	Data type	Range Min	Range Max	Description
S1	No	0	2	0	2047	B ock Address of Next Sequence Mon tor B ock
S2	No	5	2	0	2047	B ock Address of Contro Status Input
S3	No	0	2	0	2047	B ock Address of Step Tr gger
S4	No	0	1	0	2047	B ock Address of Ho d/ n t alize
S5	No	0	2	0	2047	B ock Address of Sem Auto Tr gger
S6	No	0	2	0	2047	B ock Address of Emergency Stop
S7	No	5	I1	0	2047	B ock Address of Initia Step Number
S8	Yes	0	I1	0	1	Semi Auto Permiss ve
S9	Yes	0 0	I1	0	21	Step #1 Type
S10	Yes	0	R3		Fu l	Step #2 Type
S11	Yes	0 0	R3		Full	Step #3
•						•
•						•
•						•
S16						Step #8 Type
S17						Step #1 Next
S18						Step #2 Next
•						•
•						•
•						•

TABLE 5 — Sequence Monitor Description (continued)

SPECIFICATIONS (Function Code 124)

Spec No.	Tune	Default Value	Data Type	Min	Max	Description
S24						Step #8 Next
S25						Step #1 Fault
S26						Step #2 Fau t
•						•
•						•
•						•
S32						Step #8 Fau t

TABLE 5 Sequence Monitor Description (continued)

BLOCK DETAILS

SEQUENCE MONITOR			CODE — 124 PCU4 MOD3 BLK120
S1	0	2	B ock Address of Next Sequence Mon tor B ock
S2	112	I2	B ock Address of Contro Status nput
S3	127	I1	B ock Address of Step Trigger
S4	127	I2	B ock Address of Ho d/In t al ze
S5	152	I2	B ock Address of Sem Auto Tr gger
S6	153	I2	B ock Address of Emergency Stop
S7	6	R3	n t a Step Number
S8	1	1	Sem Auto Permiss ve
S9	00	1	Step #1 Type
S10	2	R3	Step #2 Type
S11	0	R3	Step #3 Type
•			•
•			•
•			•
S16	4	R3	Step #8 Type
S17	0	R3	Step #1 Next
S18	00	1	Step #2 Next
•			•
•			•
•			•
S24	00	1	Step #8 Next
S25	7	R3	Step #1 Fau t
S26	0	R3	Step #2 Fau t
•			•
•			•
•			•
S32	0	R3	Step #8 Fault

TABLE 6 Example Sequence Monitor Block Specifications

FUNCTION CODE 161

SEQUENCE GENERATOR BLOCK

Description

The sequence generator function (SGB) code contains up to e ght output masks correspond ing to eight steps The purpose of the funct on code is to output a un que mask for each step For examp e, n step #1 then output mask #1 wi l be output (S10) If the SGB s reset, t s n the zeroth step and the output disab e mask s out put (S9) This is normal y reserved for an emergency step

There are two d fferent ways to go from one step to another First, f one needs to go from one step to another n a straight numer cal order then a trans tion of the step trigger (S2) from a 0 to ' wi cause the SGB to go to the next step Secondly if one needs to "skip' steps out of numer cal sequence, then oad the step number you want to jump to into S7 and on a trans t on of the step jump tr gger (S6) from 0 to 1 the step jump number wi l be executed

f the sequence has more than e ght steps, SGBs can be inked together n series Th s s done by having each SGB po nting to the previous one by having the b ock address of the prev ous one as the funct ona spec S1 Note that a triggers and step jump numbers must be fed nto a of the SGBs s multaneous y Further more, use on y the outputs and step number from the ast SGB in the series

OUTPUTS (Function Code 161)

Block No.	Data Type	Description
N	Boo ean	Output 1 of current step
N + 1	Boo ean	Output 2 of current step
N + 2	Boo ean	Output 3 of current step
N + 3	Boo ean	Output 4 of current step
N + 4	Boo ean	Output 5 of current step
N + 5	Boo ean	Output 6 of current step
N + 6	Boo ean	Output 7 of current step
N + 7	Boo ean	Output 8 of current step
N + 8	Real	Current step number
N + 9	Real	Seconds remaining in current step
N + 10	Boo ean	Step taken (Log c 0 to 1 trans t on

TABLE 7 Sequence Generator Block Description

SPECIFICATIONS (Function Code 161)

Spec No.	Tune	Default Value	Data Type	Range Min	Range Max	Description
S1	No	0	nt	0 to 255/2047		Start ng b ock address of prev ous Sequence Generator n Ser es (0 f rst n ser es)
S2	No	0	nt	0 to 255/2047		B ock Address of Step Tr gger (0 to 1 trans t on)
S3	No	0	nt	0 to 255/2047		B ock Address of Step Ho d 0 re ease 1 ho d
S4	No	0	nt	0 to 255/2047		B ock Address of Step t mer Ho d 0 re ease 1 ho d
S5	No	0	nt	0 to 255/2047		B ock Address of Reset Tr gger (0 to 1 trans t on)
S6	No	0	nt	0 to 255/2047		B ock Address of Step Jumper Tr gger (0 to 1 trans t on)
S7	No	5	nt	0 to 255/2047		B ock Address of Step Jump Number
S8	No	0	nt	0 to 255/2047		B ock Address of Output D sab e F ag
S9	Yes	0 000	Rea (2)	Fu		D sab e Mask
S10	Yes	0 000	Rea (2)	Fu		Step #1 Output Mask
S11	Yes	0 000	Rea (3)	Fu		Step #1 t me n seconds
S12	Yes	0 000	Rea (2)	Fu		Step #2 Output Mask
S13	Yes	0 000	Rea (3)	Fu		Step #2 t me n seconds
S14	Yes	0 000	Rea (2)	Fu		Step #3 Output Mask
S15	Yes	0 000	Rea (3)	Fu		Step #3 t me n seconds
S16	Yes	0 000	Rea (2)	Fu		Step #4 Output Mask
S17	Yes	0 000	Rea (3)	Fu		Step #4 t me n seconds
S18	Yes	0 000	Rea (2)	Fu		Step #5 Output Mask
S19	Yes	0 000	Rea (3)	Fu		Step #5 t me n seconds
S20	Yes	0 000	Rea (2)	Fu		Step #6 Output Mask
S21	Yes	0 000	Rea (3)	Fu		Step #6 t me n seconds
S22	Yes	0 000	Rea (2)	Fu		Step #7 Output Mask
S23	Yes	0 000	Rea (3)	Fu		Step #7 t me n seconds
S24	Yes	0 000	Rea (2)	Fu		Step #8 Output Mask
S25	Yes	0 000	Rea (3)	Fu		Step #8 t me n seconds

*Max mum va ue s 255 for a modu es except MFC wh ch s 2047

TABLE 7 Sequence Generator Block Description (contin ed)

STEP	1	FV5	M1	P1	FV4	FV3	FV2	FV1
0		0	1	1	0	0	0	0
1		0	1	1	1	0	0	0
2		1	1	1	0	0	0	0
3		0	1	1	0	0	0	1
4		0	1	1	0	0	1	0
5		0	1	1	0	1	0	0
6		0	1	1	0	0	0	0
7		1	1	1	0	0	0	0
8		1	1	1	0	0	0	0

TABLE 8 Example Sequence Generator Mask

FUNCTION CODE 126

REAL SIGNAL DEMULTIPLEXER

Description

The Rea S gnal Demultip exer function code se ects boolean outputs from the real input va ue An un im ted number of t ese blocks may be jo ned together to demult p ex the rea input nto the requ red boolean outputs When more than one block s used, the block designated as the group master (the first b ock - the inked list) accepts the input signal and drives the out puts for the group The master is able to dr ve an un m ted number of s ave b ocks on y for the se ect state

OUTPUTS (Function Code 126)

Block No.	Data Type	Description
N	Boo ean	Output #0 (Least S gn ficant B t)
.		
.		
.		
N + 7	Boo ean	Output #7 (Most S gn f cant B t)

SPECIFICATIONS (Function Code 126)

Spec No.	Tune	Default Value	Data Type	Range Min	Range Max	Description
S1	No	5	2	0	2047	B ock Address of Se ect Input
S2	No	0	1	0	2	Conversion type 0 Se ect (Un m ted) 1 nteger (4 b ocks) 2 BCD (4 b ocks)
S3	No	0	12	0	2047	Block address of next slave b ock

TABLE 9 Real Signal Demultiplexer Description

FUNCTION CODE 119

BOOLEAN SIGNAL MULTIPLEXER

Description

Th s b ock se ects a single s gnal from 10 nputs ard prov des t^ s s gnal as ts output A^ un m ted number of these b ocks may be jo ned together to mu t plex an unl m ted number of signa s When more than one b ock s used the f rst b ock n the ink st, the b ock des gnated as the group s master, accepts the nput s gna and provides the output Th s master s able to search an un imited number of s ave blocks w th wh ch t is inked to f nd the selected s gna

OUTPUT (Function Code 119)

Block No	Data Type	Description
N	Boo ean	Se ected Boo ean

SPECIFICATIONS (Function Code 119)

Spec No	Tune	Default Value	Data Type	Range Min	Range Max	Description
S1	No	5	2	0	2047	0 Boo ean nput
S2	No	5	2	0	2047	1 Boo ean nput
S3	No	5	I2	0	2047	2 Boo ean nput
S4	No	5	2	0	2047	3 Boo ean nput
S5	No	5	2	0	2047	4 Boo ean Input
S6	No	5	2	0	2047	5 Boo ean Input
S7	No	5	2	0	2047	6 Boo ean nput
S8	No	5	2	0	2047	7 Boo ean nput
S9	No	5	2	0	2047	8 Boo ean nput
S10	No	5	2	0	2047	9 Boo ean nput
S11	No	5	I2	0	2047	Se ect Boo ean nput
S12	No	0	2	0	2047	Next Boo ean Signa Mu t p exer

TABLE 10 Boolean Signal Multiplexer Description

FUNCTION CODE 118

REAL RECIPE TABLE

Description
The Real Rec pe Tab e funct on code se ects a s ng e rea parameter value from the conf gured recipe tab e based on a se ection input and pro v des t as the output Each b ock contains 10 rea rec pe parameter va ues The b ocks can be nked together to obta n mu tip es of 10 rea values in the recipe table The first block in the ink st s des gnated as the group master The master accepts the parameter se ect nput and s ab e to search the s ave blocks in the nk st to f nd the se ected parameter The 10 parameters n the master block are accessed by the range 0 to 9 The range 10 to 19 s associated w th the next b ock n the ink ist and so on Ed t ng of the parameters in the rec pe tab e s accomp shed by the ed t s gna edit select on, and ed t value nputs When a 0 to 1 transit on occurs on the ed t s gna nput, the master block replaces the recipe table parameter spec fied by the ed t se ection nput w th the rea va ue obta ned from the edit va ue nput Recipe parameter edit ng on y occurs in RAM and not in EEROM

OUTPUTS (Function Code 118)

B ock No.	Data Type	Description
N	Rea	Parameter va ue se ected

SPECIFICATIONS (Function Code 118)

Spec No	Tune	Default Value	Data Type	Min Max	Descr ption
S1	Yes	0 0	Real (3)	Full	Value of parameter 0
S2	Yes	0 0	Rea (3)	Fu	Value of parameter 1
S3	Yes	0 0	Rea (3)	Fu	Va ue of parameter 2
S4	Yes	0 0	Rea (3)	Fu	Va ue of parameter 3
S5	Yes	0 0	Rea (3)	Fu	Va ue of parameter 4
S6	Yes	0 0	Rea (3)	Fu	Va ue of parameter 5
S7	Yes	0 0	Rea (3)	Fu	Va ue of parameter 6
S8	Yes	0 0	Rea (3)	Fu	Va ue of parameter 7
S9	Yes	0 0	Rea (3)	Fu	Va ue of parameter 8
S10	Yes	0 0	Real (3)	Ful	Value of parameter 9
S11	No	5	nt (2)	0 to 2047	B ock Address of Parameter Se ect
S12	No	0	nt (2)	0 to 2047	B ock Address of L nk to Next Slave B ock (0 end)
S13	No	0	Int (2)	0 to 2047	B ock Address of Ed t S gna
S14	No	5	nt (2)	0 to 2047	B ock Address of Ed t Parameter Se ect
S15	No	5	nt (2)	0 to 2047	B ock Address of Ed t Va ue

TABLE 11 Real Recipe Table Description

Bailey Controls Wickliffe Ohio 44092 a division of THE BABCOCK & WILCOX COMPANY

Bailey Controls Australia Pty Ltd Regents Park N S W Australia
Bailey do Brasil Sao Paulo Brazil

Bailey Controls Div of B&W Industries Ltd Burlington Ontario Canada
Bailey Japan Company Ltd Shizuoka Ken Japan
Representatives in Other Principal Cities

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