### SECTION 1

**LOOP 1/LOOP 2/LOOP 3 FUNCTION BLOCKS**

* (Numerical Order)

<table>
<thead>
<tr>
<th>Block Code</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB101/FB201/FB301</td>
<td>Analog Input #1</td>
</tr>
<tr>
<td>FB102/FB202</td>
<td>Analog Input #2</td>
</tr>
<tr>
<td>FB103/FB203/FB303</td>
<td>Analog Output</td>
</tr>
<tr>
<td>FB104</td>
<td>Digital Output #1</td>
</tr>
<tr>
<td>FB105</td>
<td>Digital Output #2</td>
</tr>
<tr>
<td>FB106/FB206/FB306</td>
<td>Digital Input</td>
</tr>
<tr>
<td>FB107/FB207/FB307</td>
<td>Ratio</td>
</tr>
<tr>
<td>FB108/FB208/FB308</td>
<td>Bias</td>
</tr>
<tr>
<td>FB109/FB209/FB309</td>
<td>HiLo Limit</td>
</tr>
<tr>
<td>FB110/FB210/FB310</td>
<td>Override Selector</td>
</tr>
<tr>
<td>FB111/FB211/FB311</td>
<td>E/I Transfer</td>
</tr>
<tr>
<td>FB112/FB212/FB312</td>
<td>Alarms</td>
</tr>
<tr>
<td>FB113/FB213/FB313</td>
<td>Controller</td>
</tr>
</tbody>
</table>

1. PID Controller
2. PD Controller
3. I Controller
4. PID (Adaptive Gain) Controller

<table>
<thead>
<tr>
<th>Block Code</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB114/FB214/FB314</td>
<td>A/M Transfer</td>
</tr>
<tr>
<td>FB115/FB215/FB315</td>
<td>Operator's Display</td>
</tr>
<tr>
<td>FB116/FB216/FB316</td>
<td>Integrator/Totalizer</td>
</tr>
<tr>
<td>FB117/FB217/FB317</td>
<td>Setpoint Track &amp; Hold</td>
</tr>
<tr>
<td>FB118/FB218/FB318</td>
<td>General Purpose Track &amp; Hold</td>
</tr>
<tr>
<td>FB120/FB220/FB320</td>
<td>Quad Logic</td>
</tr>
<tr>
<td>FB122/FB222/FB322</td>
<td>Deviation Amplifier</td>
</tr>
<tr>
<td>FB123/FB223/FB323</td>
<td>Dual Transfer Switch</td>
</tr>
<tr>
<td>FB124</td>
<td>Square Root Extractor</td>
</tr>
<tr>
<td>FB232/FB332</td>
<td>Relay Output</td>
</tr>
<tr>
<td>FB134</td>
<td>Math</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Block Code</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB198</td>
<td>Loop 1 Local Instrument Link Interface Option</td>
</tr>
<tr>
<td>FB298</td>
<td>Loop 2 Local Instrument Link Interface Option</td>
</tr>
<tr>
<td>FB398</td>
<td>Loop 3 Local Instrument Link Interface Option</td>
</tr>
<tr>
<td>FB199</td>
<td>#3 Analog Input Options</td>
</tr>
</tbody>
</table>

**V** – Voltage Input  
**C** – Computer Pulse  
**T** – MV & T/C (J, K, T, E, R, S, B) Input  
**D** – RTD Input  
**F** – Frequency Input

*Function Block Master Drawing*
The following table lists all Function Blocks available in the Model 351 Triple-Loop Digital Controller and in which loop they reside. Please note that all Function Blocks are not available in all three loops. However, the Function Blocks may be configured for use in other loops than the particular loop in which they reside.

<table>
<thead>
<tr>
<th>FUNCTION BLOCK TYPE</th>
<th>LOOP 1/FB #</th>
<th>LOOP 2/FB #</th>
<th>LOOP 3/FB #</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANALOG INPUT #1</td>
<td>101</td>
<td>201</td>
<td>301</td>
</tr>
<tr>
<td>ANALOG INPUT #2</td>
<td>102</td>
<td>202</td>
<td>N/A</td>
</tr>
<tr>
<td>ANALOG OUTPUT</td>
<td>103</td>
<td>203</td>
<td>303</td>
</tr>
<tr>
<td>DIGITAL OUTPUT #1</td>
<td>104</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>DIGITAL OUTPUT #2</td>
<td>105</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>DIGITAL INPUT</td>
<td>106</td>
<td>206</td>
<td>306</td>
</tr>
<tr>
<td>RATIO</td>
<td>107</td>
<td>207</td>
<td>307</td>
</tr>
<tr>
<td>BIAS</td>
<td>108</td>
<td>208</td>
<td>308</td>
</tr>
<tr>
<td>HI/LO LIMIT</td>
<td>109</td>
<td>209</td>
<td>309</td>
</tr>
<tr>
<td>OVERRIDE SELECTOR</td>
<td>110</td>
<td>210</td>
<td>310</td>
</tr>
<tr>
<td>E/I TRANSFER</td>
<td>111</td>
<td>211</td>
<td>311</td>
</tr>
<tr>
<td>ALARMS</td>
<td>112</td>
<td>212</td>
<td>312</td>
</tr>
<tr>
<td>CONTROLLER</td>
<td>113</td>
<td>213</td>
<td>313</td>
</tr>
<tr>
<td>PID</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>PD</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>ID</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>PID/ADAPTIVE GAIN</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>A/M TRANSFER</td>
<td>114</td>
<td>214</td>
<td>314</td>
</tr>
<tr>
<td>OPERATOR'S DISPLAY</td>
<td>115</td>
<td>215</td>
<td>315</td>
</tr>
<tr>
<td>INTEGRATOR/TOTALIZER</td>
<td>116</td>
<td>216</td>
<td>316</td>
</tr>
<tr>
<td>SETPOINT TRACK &amp; HOLD</td>
<td>117</td>
<td>217</td>
<td>317</td>
</tr>
<tr>
<td>GEN. PURPOSE TRACK &amp; HOLD</td>
<td>118</td>
<td>218</td>
<td>318</td>
</tr>
<tr>
<td>QUAD LOGIC</td>
<td>120</td>
<td>220</td>
<td>320</td>
</tr>
<tr>
<td>DEVIATION AMPLIFIER</td>
<td>122</td>
<td>222</td>
<td>322</td>
</tr>
<tr>
<td>DUAL TRANSFER SWITCH</td>
<td>123</td>
<td>223</td>
<td>323</td>
</tr>
<tr>
<td>SQUARE ROOT EXTRACTOR</td>
<td>124</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>RELAY OUTPUT</td>
<td>N/A</td>
<td>232</td>
<td>332</td>
</tr>
<tr>
<td>MATH</td>
<td>134</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>LIL INTERFACE OPTION</td>
<td>198</td>
<td>298</td>
<td>398</td>
</tr>
<tr>
<td>#3 ANALOG INPUT OPTIONS</td>
<td>199</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>VOLTAGE</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>COMPUTER PULSE</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>MV &amp; T/C</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>RTD</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>FREQUENCY</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>
The Function Block number consists of two segments. The first segment designates which loop the block resides in, while the second segment designates the block number itself. See examples 1 and 2.

Example #1:
Complete Function Block Number ............ 101
Loop Number .................................. 1 01
Function Block Number ....................... 1 0 1

Example #2:
Complete Function Block Number ............ 201
Loop Number .................................. 2 01
Function Block Number ....................... 2 0 1

The function block pages in Section 1 are organized in such a way that identical function blocks for more than one loop will be displayed on the same page(s). Function block differences (i.e., inputs, outputs, etc.) will be listed under the separate function block numbers.

The Function Block numbers at the upper right hand corner of the page(s) show the Loop in which that particular function block resides.

The Function Block numbers may be displayed as FB*01, FB*25, etc., and the Function Block Output Numbers may be displayed as *02, *34 etc., as shown in the function block illustration. The asterisk (*) should be replaced by the selected Loop number used during configuration, configuration editing, etc.

The function block page illustrated below clearly shows the similarities, as well as the differences, between a particular type of function block for all three loops.

---

**FUNCTION BLOCK TYPE**

**FUNCTION BLOCK SIMILARITIES**

**FUNCTION BLOCK DIFFERENCES**

---

**Digital Input**

**FB106/FB206/FB306**

The function block converts an ON/OFF digital input signal into a 0-10mA output signal that is 0% when the input is OFF and 100% when ON. The normal input voltage is 24 Vdc.

**Specifications**

- **ON Voltage:** 15-30 Vdc
- **OFF Voltage:** 1.6 Vdc
- **Input Current:** 10 mA
- **Max. Current: 10 mA**
- **Max. Input: 20 Vdc**
- **Operating: 10 Vdc
- **Input: 1 Vdc**

**Output Identifications**

- FB106: Out01: 116
- FB206: Out01: 216
- FB306: Out01: 316

**Terminol Designations**

- FB106: D1: (BE)
- FB206: D1: (C1)
- FB306: D1: (C1)

---

**Block Diagram**

---

*Revised with Loop Designator 1, 2 or 3*
This function block converts an analog voltage with a range defined during calibration into a 0-100% block output for interconnection to other blocks. Also included is a digital filter that can be used to filter out process noise and a square root extractor for linearizing a flow signal from a DP transmitter. Calibration details can be found in Instruction SD351 included in Section 4 of this manual.

**Specifications**
Calibration: Zero: 0 to 1 Vdc
Span: 4 to 5 Vdc
Hardware Filter Breakpoint Frequency: 2 Hz (2-pole)
Digital Filter Range: 0.001 to 10.00 Hz
Accuracy: 0.05%
Input Impedance: >1 megohm
Max. Continuous Input: ±30 Vdc

**Output Identifications**
FB101
  Output: 101
FB201
  Output: 201
FB301
  Output: 301

**Terminal Designations**
FB101: AI+ (A4)
       AI- (A5)
FB201: AI+ (D4)
       AI- (D5)
FB301: AI+ (D7)
       AI- (D8)

**Diagram**

**Block Diagram**

*Replace with Loop Designator 1 or 2*
This function block converts an analog voltage with a range defined during calibration into a 0-100% block output for interconnection to other blocks.

Also included is a digital filter that can be used to filter out process noise and a square root extractor for linearizing a flow signal from a ΔP transmitter. Calibration details can be found in Instruction SD351 included in Section 4 of this manual.

**Specifications**
- **Calibration:** Zero: 0 to 1 Vdc
  Span: 4 to 5 Vdc
- **Hardware Filter Breakpoint Frequency:** 2 Hz (2-pole)
- **Digital Filter Range:** 0.001 to 10.00 Hz
- **Accuracy:** 0.05%
- **Input Impedance:** >1 megohm
- **Max. Continuous Input:** ±30 Vdc

**Output Identifications**
- FB102
  - Output: 102
- FB202
  - Output: 202

**Terminal Designations**
- FB102: AI2+ (A6)
  - AIC- (A5)
- FB202: AI2+ (D6)
  - AIC- (D5)

---

*Replace with Loop Designator 1 or 2.*
Analog Output

FB103/FB203/FB303

This function block converts a 0-100% block interconnection signal into a 4-20 mA dc analog output signal. Also included is a switch that will disconnect the 4-20 mA dc signal from the load. This feature can be useful when two or more outputs are connected to the same load. Calibration details can be found in Instruction SD351 included in Section 4 of this manual.

Specifications
Calibration: Zero: 4.0 mA dc ± trim
Span: 16.0 mA dc ± trim
Output Load: 0-800 ohm
Output Current Limit: 20.5 ± 0.1 mA
Open Loop Output Voltage: 26V ± 10%
Accuracy: ± 0.1%
Output Switch Action: opens when B≥80%
closes when B<75%

Terminal Designations
FB103: AO1+ (A7)
AOC– (A8)
FB203: AO1+ (D9)
AOC– (D10)
FB303: AO1+ (C5)
AOC– (C6)

*Replace with Loop Designator 1, 2 or 3.
These function blocks provide a digital transistor output. The transistor will be turned on when input A equals or exceeds 80% and will turn off when A drops below 75%. Details on connecting transistor outputs to various loads such as relays and solid state annunciators can be found in Instruction SD351 included in Section 4 of this manual.

Specifications
Output Type: NPN open collector transistor
Maximum Load Voltage: 30 Vdc
Maximum Load Current: 100 mA
Transistor Switch Action: closes when A ≥ 80%
open when A < 75%
Transistor “ON” Voltage: 0.3V (max.) @ 0 mA load
0.6V (max.) @ 100 mA load
Transistor “OFF” Leakage: 200 μA (max.) @ 30 Vdc

Terminal Designations
FB104: DO1+ (B4)
DOC− (B7)
FB105: DO2+ (B6)
DOC− (B7)

BLOCK DIAGRAM
Digital Input

This function block converts an ON/OFF digital input signal into a block interconnection signal that is 0% when the input is OFF and 100% when ON. The normal input voltage is 24 Vdc.

**Specifications**
- ON Voltage: 15-30 Vdc
- OFF Voltage: 0-1 Vdc
- Input Current @ 24 Vdc: 10 mAdc (max.)
- Max. Continuous Input: ± 30 Vdc
- Isolation: 100 Vdc
- Action: Input > 15 Vdc, 0=100%
  - Input < 1 Vdc, 0=0%

**Output Identifications**
- FB106
  - On/Off: 116
- FB206
  - On/Off: 216
- FB306
  - On/Off: 316

**Terminal Designations**
- FB106: DII+ (B8)
  - DII- (B9)
- FB206: DII+ (C7)
  - DII- (C8)
- FB306: DII+ (C9)
  - DII- (C10)

*Replace with Loop Designator 1, 2 or 3.*
This function block multiplies two inputs (A*B) by R (Ratio). All signal inputs are normalized to a range of 0-1.00 for 0-100% and a 0-1.00 computed result is converted to a 0-100% block output. Output O is equal to R*A*B. R is restricted to a value between 0 and 30. When the C input is high, the R value is re-calculated based on the D (Desired Output) input to the block. R will equal D/(A*B). The track output is always equal to D/(A*R) and can be used with an external ratio recalculation scheme.

In some applications it may be desirable to use the Ratio block’s re-calculation capability. For example, when using a ratio set controller when the E/I button is used to toggle between a ratio setpoint and an internal setpoint, a tracking ratio block can prevent a setpoint bump on transition from I to E.

Equation

\[ O = R \cdot A \cdot B \]

Output Identifications

FB107
- Output: 103
- Track Output: 189

FB207
- Output: 203
- Track Output: 289

FB307
- Output: 303
- Track Output: 389

*Replace with Loop Designator 1, 2 or 3.
This function block sums the signal input A with a bias constant (B) and an external bias (E). The external bias is automatically scaled to -100.00 - 0 - 100.00% for a 0-100% input signal. Output O is equal to A+E+B. B is restricted to a value between -100 and 100%. When the C input is high, the B value is recalculated based on the D (Desired output) input to the block. B will equal D-(A-E). The track output equals D-(A+B) and can be used with an external bias recalculating scheme. The track output range is equal to 0-100% scaled from -100 - 0 - 100%.

**Equation**

\[ 0 = A + B + E \]

**Output Identifications**

**FB108**
- Output: 104
- Track Output: 190

**FB208**
- Output: 204
- Track Output: 290

**FB308**
- Output: 304
- Track Output: 390

---

**DEFAULT VALUES**

<table>
<thead>
<tr>
<th>A</th>
<th>0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0%</td>
</tr>
<tr>
<td>D</td>
<td>0%</td>
</tr>
<tr>
<td>E</td>
<td>50% (0% BIAS)</td>
</tr>
</tbody>
</table>

**RE-CALCULATE**

C

**DESIRE OUTPUT**

D

---

*Replace with Loop Designator 1, 2 or 3.*
Hi/Lo Limit

This function block accepts a block interconnection signal as an input and provides an output that is limited within the high (HL) and low (LL) limit settings. The status of this function block will be indicated in the 4-digit alphanumeric on the operator's display panel. When the output equals the high limit setting, the alphanumeric will display HL. When the output equals the low limit setting it will display LL.

The alphanumeric statuses HL & LL will not be displayed if the HASD parameter is set to YES.

Specifications
Low Limit Range: -3.3 to 103.3%
High Limit Range: -3.3 to 103.3%
Accuracy: <0.1%
When HL < LL output = HL

Terminal Designations
FB109
- Output: 105
FB209
- Output: 205
FB309
- Output: 305

*Replace with Loop Designator 1, 2 or 3.
The override selector function block consists of two signal selectors in series. Each can be configured as HI or LO. The 4-digit alphanumeric will display “OR” whenever the output “O” is not equal to input “A”.

The function block also provides a status output “ORS” for interconnection to other function blocks. It will equal 0% when output “O” is equal to input “A” and 100% when output “O” is not equal to input “A”.

An unconfigured input will have a default value of -3.3% for a HI Signal Selector and 103.3% for a LO Signal Selector.

The alphanumeric status OR will not be displayed if the HASD parameter is set to YES.

### Output Identifications

**FB110**
- Output: 107
- Status ORS: 108

**FB210**
- Output: 207
- Status ORS: 208

**FB310**
- Output: 307
- Status ORS: 308

### Default Values

<table>
<thead>
<tr>
<th>HI</th>
<th>LO</th>
</tr>
</thead>
<tbody>
<tr>
<td>A — 3.3%</td>
<td>103.3%</td>
</tr>
<tr>
<td>B — 3.3%</td>
<td>103.3%</td>
</tr>
<tr>
<td>C — 3.3%</td>
<td>103.3%</td>
</tr>
</tbody>
</table>

**BLOCK DIAGRAM**

*Replace with Loop Designator 1, 2 or 3.*
The E/I transfer function block consists of 2 SPDT switches. Switch 1 is controlled by the E/I pushbutton on the operator's display panel. Switch 2 is controlled by input "A" (emergency internal) and will be connected to the internal input "I" whenever input "A" is equal to or greater than 80% and will return to the position indicated by the E/I lights when it drops below 75%. Emergency Internal will not force the light on the faceplate to indicate "I" nor will it keep the operator from manipulating switch 1. However, an E/I status will be shown in the alphanumeric display.

The function block also provides two status outputs. ES will equal 100% whenever the output "O" is input "E" and IS will equal 100% whenever it is input "I".

The E/I transfer can be configured as external only. When selected, the E/I pushbutton (therefore switch 1) will always remain in the "E" position. The emergency internal input will still function normally. Configuration allows for the selection of the E/I pushbutton power up position (external, internal, or last position before power outage).

When the E/I transfer function block is used, it can affect the operation of the setpoint function block FB117/FB217/FB317 (refer to description of these blocks for additional details).

**Output Identifications**

<table>
<thead>
<tr>
<th>FB11</th>
<th>FB21</th>
<th>FB311</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status IS: 110</td>
<td>Status IS: 210</td>
<td>Status IS: 310</td>
</tr>
<tr>
<td>Status ES: 125</td>
<td>Status ES: 225</td>
<td>Status ES: 325</td>
</tr>
</tbody>
</table>

*Replace with Loop Designator 1, 2 or 3.*
This function block contains four alarms. Each may be configured as an absolute or deviation alarm. The action of alarms one through four is selected during hard configuration. Each alarm may be specified as HI, LO, HDEV, LDEV, DEV, OR or NONE. If HI or LO is selected for the alarm type, the action will be as a high or low alarm on the corresponding input. The setpoint for the absolute alarm is set during soft configuration. If OR (out of range) is selected, the setpoint specification for that alarm is ignored and the action is a high alarm at 100% and a low alarm at 0%. Each alarm can have a setpoint deadband, delay in time & delay out time. Ringback may be enabled for each alarm (Ringback will cause an acknowledged alarm to reflash when the alarm condition clears provided the alarm has been configured as a flasher.)

If Alarm 1 or Alarm 2 is selected as HDEV (High Deviation), LDEV (Low Deviation), or DEV (Absolute Deviation) during hard configuration, inputs A and B will be inputs to a deviation alarm on A-B. If Alarm 3 or Alarm 4 is selected as a HDEV, LDEV or DEV during hard configuration, inputs C and D will be inputs to a deviation alarm on C-D. For example; if Alarm 2 is selected as a DEV, it is an absolute deviation alarm on A-B, and Alarm 1 may still be used as an absolute alarm on A or another deviation alarm on A and B.

The status of each alarm is indicated in the alphanumeric display. When Alarm 1, Alarm 2 or Alarm 4 is tripped, an A1, A2 or A4 will be displayed accordingly. The Alarm 3 status may be selected during hard configuration as A3 or AD. This allows the alarm status to be configured to match the alarm status in the MYCRO 352. The status outputs AS1, AS2, AS3 or AS4 will equal 100% when in alarm and 0% when not in alarm.

ENABLE and DISABLE will ENABLE or DISABLE an alarm in FB112/FB212/FB312. The four alarm parameters SEA1 through SEA4 are accessible from the quick access alarm pushbutton only, defaulting to enable. If SEA1 is selected as DIS, the Alarm 1 output, A1 alphanumeric status and flashing bargraph (if configured) will not be active until SEA1 is changed to EN over the Local Instrument Link or at the station. These parameters are active even if a Link board is not installed.
Alarms

FB112
Status AS1: 111
Status AS2: 112
Status AS3: 113
Status AS4: 191

FB212
Status AS1: 211
Status AS2: 212
Status AS3: 213
Status AS4: 291

FB312
Status AS1: 311
Status AS2: 312
Status AS3: 313
Status AS4: 391

---

FB+12

**INPUT A**
- **ALARM #1**
- **STATUS AS1**

**INPUT B**
- **ALARM #2**
- **STATUS AS2**

**INPUT C**
- **ALARM #3**
- **STATUS AS3**

**INPUT D**
- **ALARM #4**
- **STATUS AS4**

- **S A A 1** SETPOINT ALARM 1
  - -3.3 to 103.3%
- **S A A 2** SETPOINT ALARM 2
  - -3.3 to 103.3%
- **S A A 3** SETPOINT ALARM 3
  - -3.3 to 103.3%
- **S A A 4** SETPOINT ALARM 4
  - -3.3 to 103.3%
- **S D A 1** DEADBAND ALARM 1
  - 0.1/0.5/15%
- **S D A 2** DEADBAND ALARM 2
  - 0.1/0.5/15%
- **S D A 3** DEADBAND ALARM 3
  - 0.1/0.5/15%
- **S D A 4** DEADBAND ALARM 4
  - 0.1/0.5/15%

- **S A E 1** ENABLE/DISABLE ALARM 1
  - ENDIS
- **S A E 2** ENABLE/DISABLE ALARM 2
  - ENDIS
- **S A E 3** ENABLE/DISABLE ALARM 3
  - ENDIS
- **S A E 4** ENABLE/DISABLE ALARM 4
  - ENDIS

- **H A 1 T** ALARM 1 TYPE
  - N/NO/HLLO/HDEV/LODEV/DEV/DEVR
- **H A 2 T** ALARM 2 TYPE
  - N/NO/HLLO/HDEV/LODEV/DEV/DEVR
- **H A 3 T** ALARM 3 TYPE
  - N/NO/HLLO/HDEV/LODEV/DEV/DEVR
- **H A 4 T** ALARM 4 TYPE
  - N/NO/HLLO/HDEV/LODEV/DEV/DEVR

- **H I N A** INPUT A
  - 000 to 399
- **H I N B** INPUT B
  - 000 to 399
- **H I N C** INPUT C
  - 000 to 399
- **H I N D** INPUT D
  - 000 to 399

- **H A 1 I** ALARM 1 DELAY IN TIME
  - 0.0/0.4/1/2/5/15/50/60 SEC
- **H A 2 I** ALARM 2 DELAY IN TIME
  - 0.0/0.4/1/2/5/15/50/60 SEC
- **H A 3 I** ALARM 3 DELAY IN TIME
  - 0.0/0.4/1/2/5/15/50/60 SEC
- **H A 4 I** ALARM 4 DELAY IN TIME
  - 0.0/0.4/1/2/5/15/50/60 SEC

- **H A 1 O** ALARM 1 DELAY OUT TIME
  - 0.0/0.4/1/2/5/15/50/60 SEC
- **H A 2 O** ALARM 2 DELAY OUT TIME
  - 0.0/0.4/1/2/5/15/50/60 SEC
- **H A 3 O** ALARM 3 DELAY OUT TIME
  - 0.0/0.4/1/2/5/15/50/60 SEC
- **H A 4 O** ALARM 4 DELAY OUT TIME
  - 0.0/0.4/1/2/5/15/50/60 SEC

- **H A 1 R** ALARM 1 RINGBACK
  - NO/YES
- **H A 2 R** ALARM 2 RINGBACK
  - NO/YES
- **H A 3 R** ALARM 3 RINGBACK
  - NO/YES
- **H A 4 R** ALARM 4 RINGBACK
  - NO/YES
- **H A 3 S** ALARM 3 ALPHANUMERIC STATUS
  - A3/AD

---

*Replace with Loop Designator 1, 2 or 3.
*Note: Only available from Quick Access.

AD531-10 Issue: 5/90
The controller function block provides an extensive range of Proportional-Integral-Derivative functions including: PID, PD, ID, and PID with Adaptive Gain.

1. **PID CONTROLLER**

The PID controller is a reset type which uses external feedback to establish integral action.

The function block has a "Track Command" input ("C") which will force the output to track the feedback ("F") when the input "C" signal is equal to or greater than 80% and will stop tracking when it drops below 75%.

If the derivative time TD is set equal to 0.00, the derivative section is eliminated.

Equations

\[ 0 = GE + R \]

NORMAL (C = 0%) \[ R = \frac{F}{TIs + 1} \]

WHEN OUTPUT (0) IS CONNECTED TO FEEDBACK (F)

\[ 0 = \frac{P}{Tds + 1} - S \]

\[ TRACK \ (C = 100\%) \ F = \frac{F}{G} - GE \quad 0 = F \]

Output Identifications

**FB113**
- Output: 114
- [Error]: 115

**FB213**
- Output: 214
- [Error]: 215

**FB313**
- Output: 314
- [Error]: 315

*Replace with Loop Designator 1, 2 or 3.*
2. PD CONTROLLER

The PD controller is a proportional only with manual reset which can be selected as tracking or non-tracking.

The "Track Command" input ("C") will force the controller output to track the feedback and if manual reset tracking was selected, the manual reset (MR) will also track the feedback. In either case, the controller will always go back to normal action with the output equal to the feedback. The reset value (R) will then return to the value of MR with a time constant established by the integral time (TI). Since the default value of TI is 100 min. it should be reduced (e.g. 0.01 min.) when using this controller type.

The TI Time Constant is selected for the rate at which the controller should return to normal operation after switching from manual to auto. Bear in mind that the TI time in the PD Controller is not an integral time and does not affect control stability.

If the derivative time TD is set equal to 0.00, the derivative section is eliminated.

Equations

\[ 0 = GE + R \]

\[ R = \frac{F}{TIs + 1} \]

\[ IF \ MRT = YES \]

\[ R = F - GE \]

\[ MR = F \]

Output Identifications

FB113
Output: 114
|Error|: 115

FB213
Output: 214
|Error|: 215

FB313
Output: 314
|Error|: 315

*Replace with Loop Designator 1, 2 or 3.
3. ID CONTROLLER

The ID is an integral only controller which uses external feedback to establish integral action.

The "Track Command" input ("C") will force the controller output to track the feedback.

If the derivative time TD is set to 0.00, the derivative section is eliminated.

The gain for this controller is fixed at a value of 1.00. While the displayed gain can be changed, it will not affect the controller.

Equations

\[ 0 = \frac{GE + F}{TIS + 1} \]

NORMAL (C = 0%)

WHEN OUTPUT (O) IS CONNECTED TO FEEDBACK (F)

\[ 0 = +/ - PG \left[ \left( 1 + \frac{TDs}{(TD/DO)s + 1} \right) - S \left( \frac{1}{TIS} \right) \right] \]

TRACK (C = 100%)  \( 0 = F \)

Output Identifications

FB113
- Output: 114
- |Error|: 115

FB213
- Output: 214
- |Error|: 215

FB313
- Output: 314
- |Error|: 315

*Replace with Loop Designator 1, 2 or 3.*
4. **PID (ADAPTIVE GAIN) CONTROLLER**

The PID (AG) controller is similar to the PID except that a multiplier is placed after the proportional gain section. The gain of this multiplier will vary from 0.00 to 1.00 as the signal (input "A") varies from 0 to 100%. If input "A" is not configured, the gain is set to 1.00.

**Equations**

\[ 0 = GE + R \]

NORMAL \( (C = 0\%) \)

\[ R = \frac{F}{Ts + 1} \]

\[ 0 = +/ - PG \cdot AG \left( 1 + \frac{TDs}{(TD/DG)s + 1} \right) - S \left[ 1 + \frac{1}{Ts} \right] \]

TRACK \( (C = 100\%) \)

\[ R = F - GE \times 0 = F \]

**Output Identifications**

**FB113**
- Output: 114
- Error: 115

**FB213**
- Output: 214
- Error: 215

**FB313**
- Output: 314
- Error: 315

---

*Replace with Loop Designator 1, 2 or 3.*
The A/M transfer function block consists of 3 SPDT switches. Switch 1 is controlled by the A/M pushbutton on the operator's display panel. Switch 2 is controlled by input "E" (emergency manual) and will be connected to the (M) manual hold when input "E" is equal to or greater than 80% and will return to the position indicated by the A/M lights when it drops below 75%. Emergency manual will not force the lights on the display to indicate "M", nor will it keep the operator from manipulating switch 1. Switch 3 is controlled by input "S" (standby sync) and will be connected to input "T" when input "S" is equal to or greater than 80% and will return to its normal position when it drops below 75%.

The manual (M) can be adjusted with the pulser when it is the function block output and the 4-1/2 digit meter is displaying the valve (V) or process (P) variables. When the manual (M) is not the function block output, it will track the output value.

When the emergency manual (E) input is high, the 4 digit alphanumeric will display "EM" and when the standby sync (S) input is high, it will display "SS".

The function block also supplies a status output (MS) that will equal 100% whenever it is in manual, emergency manual, or standby sync and 0% when not.

The A/M transfer can be configured as auto only. When selected the A/M pushbutton (therefore switch 1) will always remain in the "A" position. Emergency manual and standby sync will still function normally.

Configuration allows for selecting the A/M pushbutton power up position (auto, manual, or last position before power outage). When the function block powers up in manual, and HPUL is selected as NO, the value of M can be set in configuration from -3.3 to 103.3%. When the function block powers up in manual, and HPUL is selected as YES, the output of the block on power up is set to the last output before power down.

Output Identifications
FB114
Output: 117
Status MS: 118
FB214
Output: 217
Status MS: 218
FB314
Output: 317
Status MS: 318

*Replace with Loop Designator 1, 2 or 3.
## Operators Display

**FB115/FB215/FB315**

### Pushbuttons
Active only when the TLDC contains a link interface board and FB*98 is configured for the selected loop. The pushbutton selects operational control of the selected loop. A green C on the front panel indicates operation from a console/computer through the link interface and a red L indicates the loop can be operated locally from the operators display panel.

Active only when FB*11 is configured for the selected loop. It functions as a two position switch monitored by FB*11. A green E indicates FB*11 is in the EXTERNAL position and a red I indicates FB*11 is in the INTERNAL position (see description of FB111/FB211/FB311).

Active only when FB*14 is configured for the selected loop. It functions as a two position switch monitored by FB*14. A green A indicates FB*14 is in the AUTOMATIC position and a red M indicates FB*14 is in the MANUAL position (see description of FB114/FB214/FB314).

Used to change the loop being displayed. A green backlit loop indicator will turn on to indicate the selected loop (Loop 1, Loop 2 or Loop 3).

Only those variables associated with the selected loop will be displayed in the 4-1/2 digit display. Only those alphanumeric messages associated with the selected loop will be displayed in the alphanumeric display. The quick access pushbuttons provide access to the parameters of the selected loop. When configuring, only the function block parameters of the selected loop can be entered.

Used to acknowledge a flashing bargraph display of the selected loop or any of the loops if that particular loop's HACK is configured as YES. As many as five conditions per loop may be configured to initiate a flashing bargraph. Using HSCF, the flashing bargraph may be configured to always require the ACK pushbutton to be pressed (or an acknowledged INA) to acknowledge the flashing bargraphs or to clear itself when the condition is no longer active.

### ACK

*(Replace with Loop Designator 1, 2 or 3)*

(1) Any one of the following status conditions can be selected to flash the P/S bargraph:

- **0**: NOT USED
- **01**: ALARM #1 (A1)
- **02**: ALARM #2 (A2)
- **03**: ALARM #3 (A3 or AD)
- **04**: OVERRIDE (OR)
- **05**: STANDBY SYNC (SS)
- **06**: EMERGENCY MANUAL (EM)
- **07**: EMERGENCY INTERNAL (EI)
- **08**: EMERGENCY LOCAL (EL)
- **09**: NON-UPDATING INPUT (NU)
- **10**: USER DEFINED STATUS 1 (**)
- **11**: USER DEFINED STATUS 2 (**)
- **12**: USER DEFINED STATUS 3 (**)
- **13**: ERROR (E)
- **14**: OVERLOAD (OL)
- **15**: LOW LIMIT (LL)
- **16**: OVER Limit (UL)
- **17**: EXCITE LEVEL (EL)
- **18**: EXCITE OFF (EO)
- **19**: EXCITE ON (EO)
- **20**: EXCITE OR (OR)
- **21**: EXCITE AND (AD)
- **22**: EXCITE OR AND (OR AD)
- **23**: EXCITE AND OR (AD OR)
- **24**: EXCITE AND OR AND (AD OR AD)
- **25**: EXCITE OR AND OR (OR AD OR)
- **26**: EXCITE AND OR AND OR (AD OR AD OR)

**Refer to Character Identification Table**

(continued on next page)
Used to change the displayed variable on the 4-1/2 digit display. A backlit letter will turn on to indicate the variable P, S, V, X or Y. Only those variables whose inputs have been configured will be selected. Variables P, S and V will also be displayed on analog indicators.

When the Model 351 is not in the configuration mode, this pushbutton is used to scroll the Loop Tag Name (LTN), Engineering Units (EU), Link Station Address (LSA), Data Base Revision Number (DRN), Station Identification (SID) and Configuration Filename (CFN). The 12 character loop tag name, 4 character engineering units and 12 character station identification may be configured in the Operator's Display function block (FB'15) using the arrow keys and pulser knob. Refer to the "Character Identification" table for a list of available characters. The link station address may be configured in function block FB'98.

The data base revision number is automatically incremented when the Model 351's configuration is changed. The configuration filename is the name of the configuration as stored by the Model 351 configuration software. This Tag data is scrolled in the alphanumeric display for a configured amount of time set by the Tag Scroll Time (STST).

**Inputs**

P, S, V, X and Y display inputs — P, S, X, and Y can be displayed in engineering units or 0-100%. V is displayed in 0-100%.

A — When this input goes high (≥80%) it will function the same as pushing the ACK pushbutton (i.e. to stop a flashing bargraph). This permits other means of acknowledging a flashing bargraph (e.g. a common external pushbutton, a command from a console, etc.).

Input 1 & Input 2 — Will cause user defined status 1 and user defined status 2 to be displayed in the alphanumeric. Will activate the status display when the input is ≥80% and deactivates when it is <75%. The user defined status may be selected during configuration to be meaningful messages to the operator. Refer to "Character Identification" table for a list of available characters. (Note: This status memory may not be the same as any of the pre-defined statuses listed on the previous page.)

**Output Identifications**

Pulse-On: *19 — Will go from 0% to 100% and remain at 100% for 0.5 second any time the flasher for the respective Loop 1, Loop 2 or Loop 3 turns on.

Pulse-Off: *26 — Will go from 0% to 100% and remain at 100% for 0.5 second any time the flasher for the respective Loop 1, Loop 2 or Loop 3 turns off.

Error: *06 — Will go from 0% to 100% whenever the respective error status is displayed in the alphanumeric.

### Character Identification

<table>
<thead>
<tr>
<th>Character</th>
<th>Name</th>
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<th>Character</th>
<th>Name</th>
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<td>blank</td>
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<td>0</td>
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<td>)</td>
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<td>asterisk</td>
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<td>equal sign</td>
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<td>^</td>
<td>caret</td>
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<tr>
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</tbody>
</table>

*Replace with Loop Designator 1, 2 or 3.*

(continued on next page)
Operators Display

FB115/FB215/FB315 (cont'd)

FB115

4-1/2 DIGIT METER

LOOP 1

TO FB198

TO FB111

TO FB114

P
D
S
D
M

VALVE BARGRAPH

ALPHANUMERIC DISPLAY

ACK

D

PULSE-OFF

STATUS MONITOR & FLASHER

ERROR

PULSE-ON

1

2

FB215

4-1/2 DIGIT METER

LOOP 2

TO FB298

TO FB211

TO FB214

P
D
S
D
M

VALVE BARGRAPH

ALPHANUMERIC DISPLAY

ACK

D

PULSE-OFF

STATUS MONITOR & FLASHER

ERROR

PULSE-ON

1

2

FB315

4-1/2 DIGIT METER

LOOP 3

TO FB398

TO FB311

TO FB314

P
D
S
D
M

VALVE BARGRAPH

ALPHANUMERIC DISPLAY

ACK

D

PULSE-OFF

STATUS MONITOR & FLASHER

ERROR

PULSE-ON

1

2

BLOCK DIAGRAM
The integrator provides a pulse rate output proportional to input A. The full scale rate can be set during configuration from 1 to 18,000 pulses/hour. The on-time for each pulse is fixed at 0.1 sec. A Zero Drop Out feature is included which will cause the integrator to stop pulsing when input A drops below the ZDO setting.

The pulse output (127/227/327) can be connected to any of the digital output function blocks to drive a remote counter. In addition, internal counters are included in the function block. Counter B totalizes from 0 to 4000 and counter A totalizes from 0 to 999. Together, the counters totalize from 0,000,000 to 4,000,000 and will roll over. (Counter B increments once whenever Counter A rolls over.) By selecting BYPP as yes, only totalizer B will be active. The counter will then totalize from 0 to 4000. The counters reset to zero when input R equals or exceeds 80% on a rising edge.

The output of the counters can be displayed on X and Y in FB115/FB215/FB315 by setting the LO values (e.g., XL) at 128 and the HI values (e.g., XH) at 3968. Counter A will automatically roll over at 999 and Counter B will roll over at 4000.

SHCA and SHCB are used to set a count trippoint. SHCA is a count comparator for total A and SHCB is a count comparator for total B. The two settings work together as one trippoint in that the full total of A & B must be met for output 193/293/393 to be high. This comparator provides a 100% block output when both High-Count Totalizer A and High-Count Totalizer B are at maximum count, and a 0% output when below trippoint. If the bypass totalizer feature is utilized only trippoint SHCB will be active. SHCA will be ignored by the configuration and should be set to 0 counts.

**Output Identifications**

**FB116**
- Pulses: 127
- High-Count Status: 193
- Total A: 192
- Total B: 128

**FB216**
- Pulses: 227
- High-Count Status: 293
- Total A: 292
- Total B: 228

**FB316**
- Pulses: 327
- High-Count Status: 393
- Total A: 392
- Total B: 328

---

*Replace with Loop Designator 1, 2 or 3.
This function block is a setpoint track & hold and its hold value can be changed when the 4-1/2 digit display is displaying the setpoint (S) variable. If HAIE is selected as no, and the E/I transfer (FB*11) is being used, the setpoint can be changed only while displaying S and FB*11 is in the internal position. If HAIE is selected as yes, the FB117 hold value can be changed whenever the 4-1/2 digit display is displaying the setpoint (S) variable regardless of the position of the E/I transfer block. An alternate method of changing a hold value is to display the block output ("22") on the X or Y variables. Then, when X or Y is displaying the block output, the hold value can always be changed by the pulser regardless of the HAIE parameter selection.

The function block can be placed in a tracking mode by making input "C" equal to or greater than 80%. It will return to a normal mode when input "C" drops below 75%. While in a tracking mode, the hold value will track input "T". The pulser will not affect the hold value while the block is tracking.

Output Identifications
FB117
  Output: 122
FB217
  Output: 222
FB317
  Output: 322

*Replace with Loop Designator 1, 2 or 3.
Similar to FB*17 except the hold value (H) can be entered during configuration as well as with the pulser. The pulser can change the hold value if the X or Y variable of FB*15 is displaying output (*23). If used as a constant, do not display output on X or Y.

The block output will track input T (INT) when the track command (INC) is equal to or greater than 80% and will stop tracking when INC drops below 75%.

*Replace with Loop Designator 1, 2 or 3.
This logic block provides the ability to perform logic functions on four pairs of inputs to provide four outputs.

Logic elements are individually selected for a designated pair of inputs. Functions include AND, NAND, OR, NOR, EOR (Exclusive OR).

Configuration consists of selecting the required type of logic for a pair of inputs and entering function block output numbers for the inputs.

Inputs 1 and 2 in the truth table can be any pair of inputs (A&B, C&D, E&F, or G&H) of the quad logic function block.

An unconfigured input to a logic element selected as AND/NAND will default to 100%. An unconfigured input to a logic element selected as OR/NOR/EOR will default to 0%.

Truth Table

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
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<tbody>
<tr>
<td></td>
<td>Logic Types</td>
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<tr>
<td>1 2</td>
<td>AND NAND OR NOR EOR</td>
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<td>0 1 1 0 1</td>
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<td>0 1 1 0 1</td>
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<tr>
<td>1 1</td>
<td>1 0 1 0 0</td>
</tr>
</tbody>
</table>

Output Identifications

FB120
- Element 1: 120
- Element 2: 121
- Element 3: 152
- Element 4: 153

FB220
- Element 1: 220
- Element 2: 221
- Element 3: 252
- Element 4: 253

FB320
- Element 1: 320
- Element 2: 321
- Element 3: 352
- Element 4: 353

*Replace with Loop Designator 1, 2 or 3.*
Deviation Amplifier

This function block computes the difference between inputs A and B and multiplies it by a gain value selected during configuration. The result is summed with a third input C and a bias constant (-100.00 to 100.00%) set during configuration to form the block output.

Equation
\[ 0 = G \times (A - B) + C + \text{Bias} \]

Output Identifications
- FB122
  - Output: 129
- FB222
  - Output: 229
- FB322
  - Output: 329

**Default Values**

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Block Diagram**

*Replace with Loop Designator 1, 2 or 3.*
The Dual Transfer Switch will select as block inputs “A” or “B” and “D” or “E,” depending on the level of input “C.”

When input “C” is equal to or greater than 80% it will transfer the switches from the normal positions shown in the block diagram. When input “C” drops below 75% the switches will return to their normal positions.

Output Identifications
FB123
Output 1: 163
Output 2: 164

FB223
Output 1: 263
Output 2: 264

FB323
Output 1: 363
Output 2: 364

*Replace with Loop Designator 1, 2 or 3.*
This function block will extract the square root of a 0-100% input signal. In addition, the output will be limited to 0% if input "A" drops below 0%.

Output Identification
FB123: 144
This function block provides a relay output with SPDT contacts. The relay can be configured as direct so that it energizes when input $A$ equals or exceed 80% or reverse so that it de-energizes when input $A$ equals or exceeds 80%. The relay will return to its normal condition when $A$ drops below 75%.

**Specifications**
- **Relay Type:** Hermetically sealed
- **Contact Configuration:** SPDT
- **Contact Rating:** 1 amp @ 115 Vac
- **Action:**
  - Direct: Energized when $A \geq 80\%$
  - Reverse: De-energized when $A < 75\%$

**Terminal Designations**
- **FB232**
  - R1NO (C1)
  - R1C (C2)
  - R1NC (C3)
- **FB332**
  - R1NO (D1)
  - R1C (D2)
  - R1NC (D3)

**Diagram**

**Block Diagram**

**Contacts are shown in the de-energized (normal) condition.**

*Replace with Loop Designator 2 or 3.*
Signal Equation

\[ S_0 = G_0 \left[ \left( G_A + S_A + B_A \right) \text{ OPERATION A} \left( G_B + S_B + B_B \right) \right] \text{ OPERATION B} \left[ G_C + S_C + B_C \right] + B_0 \]

\[-/+ / \times / \div \]

\( S_A, S_B \) and \( S_C \) are the 0–100% A, B and C inputs normalized to a 0–1 range.

\( S_0 \) is the normalized signal output. A range of 0–1 will be converted to a 0–100% block output. The block output is limited at -3.3% and 103.3%.

Output Identification

FB134
Output: 134
The Local Instrument Link Interface (FB198) connects Loop 1 of the Model 351 TLDC to a Local Instrument Link using an enhanced HDLC RS-422 serial communications protocol. The Local Instrument Link can consist of just two Model 351's or up to sixty-four stations consisting of devices such as Model 352 Single-Loop Digital Controllers, Model 382 Logic and Sequence Controllers, Model 324 Programmable Sequence Controllers, Model 383 Multi-Point Display Stations, Model 320 Independent Computer Interfaces and the Model 321 Expansion Satellite.

Each Model 351 transmits 46 channels of data every 0.5 second. 5 channels can be configured in Loop 1 as inputs to the link. A combined total of 15 channels can be configured as FB198, FB298 and FB398 inputs to be transmitted over the link.

The Model 351 also receives data from other stations which can be assigned during configuration to FB198 outputs 170 and 171. If any one of these outputs is not receiving its data and its NU status trigger was configured as YES, the loop's link interface NU status output will go from 0% to 100%. Local Data received is also retransmitted back on the Local Instrument Link using channels 41 and 42.

An Emergency Local input can be used to override the C/L pushbutton and put the loop in Emergency Local when the input, INL, is high (i.e. ≥ 80%). This feature can be used with a computer watchdog timer to lockout computer commands where a failure is detected. Output 179 will indicate the actual source when the loop is in the "C" mode. If output 179 is 100%, the source is a "COMPUTER" and 0% it is a "CONSOLE". Output 196 is 100% if the C/L pushbutton is in the C position and 0% if it is in the L position, regardless of the Emergency Local status. Output 195 is 100% if the loop is in "EMERGENCY LOCAL". The activated Emergency Local input does not change the C/L light on the Model 351 faceplate.

HRLO provides added security on a station by station basis. If HRLO is set as YES, the 351 will not accept record transfers i.e., a configuration download from a computer. HPLO is set on a loop-by-loop basis. If HPLO is set as YES, Loop 1 will not accept parameter change commands.
For a Model 351 to communicate on the Local Instrument Link it must have an address. This Link Station Address (LSA) may be set in FB198, FB298 or FB398. However, each station may have only one address. Therefore, as an example, if HLSA in FB198 is changed, this change will be reflected in HLSA of FB298 and FB398.

The interface also performs a number of alarm functions on signals being transmitted by the Model 351 over the link. These can be used by consoles or computers to provide detection, logging and acknowledgement of alarms. Since these functions are not concerned with LOCAL operation of the Model 351, details are not included in this manual except for the listing of their configuration parameters under "Local Instrument Link Parameters". Details on these functions along with a complete listing of the 48 channels of the transmitted data, parameters that can be requested and changed (e.g. "controller tuning"), and other Link Interface commands can be found in AD351-40, "Model 351 TLDC Link Interface Communications User's Manual".

### Transmitted Data

<table>
<thead>
<tr>
<th>Input</th>
<th>Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1P</td>
<td>8</td>
</tr>
<tr>
<td>L1S</td>
<td>9</td>
</tr>
<tr>
<td>L1V</td>
<td>10</td>
</tr>
<tr>
<td>L1A</td>
<td>23</td>
</tr>
<tr>
<td>L1B</td>
<td>26</td>
</tr>
</tbody>
</table>

### Received Data

<table>
<thead>
<tr>
<th>Output</th>
<th>Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>170</td>
<td>41</td>
</tr>
<tr>
<td>171</td>
<td>42</td>
</tr>
</tbody>
</table>
The Local Instrument Link Interface (FB298) connects Loop 2 of the Model 351 TLDC to a Local Instrument Link using an enhanced HDLC RS-422 serial communications protocol. The Local Instrument Link can consist of just two Model 351's or up to sixty-four stations consisting of devices such as Model 352 Single-Loop Digital Controllers, Model 382 Logic and Sequence Controllers, Model 324 Programmable Sequence Controllers, Model 383 Multi-Point Display Stations, Model 320 Independent Computer Interfaces and the Model 321 Expansion Satellite.

Each Model 351 transmits 46 channels of data every 0.5 second. 5 channels can be configured in Loop 2 as inputs to the link. A combined total of 15 channels can be configured as FB196, FB298 and FB398 inputs to be transmitted over the link.

The Model 351 also receives data from other stations which can be assigned during configuration to FB298 outputs 270 and 271. If any one of these outputs is not receiving its data and its NU status trigger was configured as YES, the loop’s link interface NU status output will go from 0% to 100%. Local Data received is also retransmitted back on the Local Instrument Link using channels 43 and 44.

An Emergency Local input can be used to override the C/L pushbutton and put the loop in Emergency Local when the input, INL, is high (i.e. ≥ 80%). This feature can be used with a computer watchdog timer to lockout computer commands where a failure is detected. Output 279 will indicate the actual source when the loop is in the “C” mode. If output 279 is 100%, the source is a “COMPUTER” and 0% it is a “CONSOLE”. Output 296 is 100% if the C/L pushbutton is in the C position and 0% if it is in the L position, regardless of the Emergency Local status. Output 295 is 100% if the loop is in "EMERGENCY LOCAL". The activated Emergency Local input does not change the C/L light on the Model 351 faceplate.

HRLO provides added security on a station by station basis. If HRLO is set as YES, the 351 will not accept record transfers. i.e., a configuration download from a computer. HPLO is set on a loop-by-loop basis. If HPLO is set as YES, Loop 2 will not accept parameter change commands.

(continued on next page)
For a Model 351 to communicate on the Local Instrument Link it must have an address. This Link Station Address (LSA) may be set in FB198, FB298 or FB398. However, each station may have only one address. Therefore, as an example, if HLSA in FB298 is changed, this change will be reflected in HLSA of FB198 and FB398.

The interface also performs a number of alarm functions on signals being transmitted by the Model 351 over the link. These can be used by consoles or computers to provide detection, logging and acknowledgement of alarms. Since these functions are not concerned with LOCAL operation of the Model 351, details are not included in this manual except for the listing of their configuration parameters under “Local Instrument Link Parameters”. Details on these functions along with a complete listing of the 46 channels of the transmitted data, parameters that can be requested and changed (e.g. “controller tuning”), and other Link Interface commands can be found in AD351-40, “Model 351 TLDC Link Interface Communications User’s Manual”.

**Transmitted Data**

<table>
<thead>
<tr>
<th>Input</th>
<th>Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2P</td>
<td>13</td>
</tr>
<tr>
<td>L2S</td>
<td>14</td>
</tr>
<tr>
<td>L2V</td>
<td>15</td>
</tr>
<tr>
<td>L2A</td>
<td>29</td>
</tr>
<tr>
<td>L2B</td>
<td>32</td>
</tr>
</tbody>
</table>

**Received Data**

<table>
<thead>
<tr>
<th>Output</th>
<th>Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>270</td>
<td>43</td>
</tr>
<tr>
<td>271</td>
<td>44</td>
</tr>
</tbody>
</table>

**LOCAL INSTRUMENT LINK PARAMETERS (EXTERNAL)**

The following Model 351 information are configuration parameters for external devices of a Local Instrument Link (e.g. computers, control consoles, etc.). These parameters cannot be configured at the faceplate of the Model 351.

<table>
<thead>
<tr>
<th>A A 1 L</th>
<th>CHANNEL L2A ALARM #1 LIMIT ...... -3.3 to 103.3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>A A 2 L</td>
<td>CHANNEL L2A ALARM #2 LIMIT ...... -3.3 to 103.3%</td>
</tr>
<tr>
<td>A A 3 L</td>
<td>CHANNEL L2A ALARM #3 LIMIT ...... -3.3 to 103.3%</td>
</tr>
<tr>
<td>A A 4 L</td>
<td>CHANNEL L2A ALARM #4 LIMIT ...... -3.3 to 103.3%</td>
</tr>
<tr>
<td>B A 1 L</td>
<td>CHANNEL L2B ALARM #1 LIMIT ...... -3.3 to 103.3%</td>
</tr>
<tr>
<td>B A 2 L</td>
<td>CHANNEL L2B ALARM #2 LIMIT ...... -3.3 to 103.3%</td>
</tr>
<tr>
<td>B A 3 L</td>
<td>CHANNEL L2B ALARM #3 LIMIT ...... -3.3 to 103.3%</td>
</tr>
<tr>
<td>B A 4 L</td>
<td>CHANNEL L2B ALARM #4 LIMIT ...... -3.3 to 103.3%</td>
</tr>
<tr>
<td>A A 1 T</td>
<td>CHANNEL L2A ALARM #1 TYPE WORD ..... ATW</td>
</tr>
<tr>
<td>A A 2 T</td>
<td>CHANNEL L2A ALARM #2 TYPE WORD ..... ATW</td>
</tr>
<tr>
<td>A A 3 T</td>
<td>CHANNEL L2A ALARM #3 TYPE WORD ..... ATW</td>
</tr>
<tr>
<td>A A 4 T</td>
<td>CHANNEL L2A ALARM #4 TYPE WORD ..... ATW</td>
</tr>
<tr>
<td>B A 1 T</td>
<td>CHANNEL L2B ALARM #1 TYPE WORD ..... ATW</td>
</tr>
<tr>
<td>B A 2 T</td>
<td>CHANNEL L2B ALARM #2 TYPE WORD ..... ATW</td>
</tr>
<tr>
<td>B A 3 T</td>
<td>CHANNEL L2B ALARM #3 TYPE WORD ..... ATW</td>
</tr>
<tr>
<td>B A 4 T</td>
<td>CHANNEL L2B ALARM #4 TYPE WORD ..... ATW</td>
</tr>
</tbody>
</table>

ATW – Alarm Type Word is a 12-bit word that defines the alarm type. Details on each type word can be found in the Model 351 Link Communications User’s Manual AD351-40.
The Local Instrument Link Interface (FB398) connects Loop 3 of the Model 351 TLD to a Local Instrument Link using an enhanced HDLC RS-422 serial communications protocol. The Local Instrument Link can consist of just two Model 351's or up to sixty-four stations consisting of devices such as Model 352 Single-Loop Digital Controllers, Model 382 Logic and Sequence Controllers, Model 324 Programmable Sequence Controllers, Model 383 Multi-Point Display Stations, Model 320 Independent Computer Interfaces and the Model 321 Expansion Satellite.

Each Model 351 transmits 46 channels of data every 0.5 second. 5 channels can be configured in Loop 3 as inputs to the link. A combined total of 15 channels can be configured as FB198, FB298 and FB398 inputs to be transmitted over the link.

The Model 351 also receives data from other stations which can be assigned during configuration to FB398 outputs 370 and 371. If any one of these outputs is not receiving its data and its NU status trigger was configured as YES, the loop's link interface NU status output will go from 0% to 100%. Local Data received is also retransmitted back on the Local Instrument Link using channels 45 and 46.

An Emergency Local input can be used to override the C/L pushbutton and put the loop in Emergency Local when the input, INL, is high (i.e., ≥ 80%). This feature can be used with a computer watchdog timer to lockout computer commands where a failure is detected. Output 379 will indicate the actual source when the loop is in the "C" mode. If output 379 is 100%, the source is a "COMPUTER" and 0% is a "CONSOLE". Output 396 is 100% if the C/L pushbutton is in the C position and 0% if it is in the L position, regardless of the Emergency Local status. Output 395 is 100% if the loop is in "EMERGENCY LOCAL". The activated Emergency Local input does not change the C/L light on the Model 351 faceplate. HRLO provides added security on a station by station basis. If HRLO is set as YES, the 351 will not accept record transfers, i.e., a configuration download from a computer. HPLO is set on a loop-by-loop basis. If HPLO is set as YES, Loop 3 will not accept parameter change commands.
For a Model 351 to communicate on the Local Instrument Link it must have an address. This Link Station Address (LSA) may be set in FB198, FB298 or FB398. However, each station may have only one address. Therefore, as an example, if HLSA in FB398 is changed, this change will be reflected in HLSA of FB198 and FB298.

The interface also performs a number of alarm functions on signals being transmitted by the Model 351 over the link. These can be used by consoles or computers to provide detection, logging and acknowledgement of alarms. Since these functions are not concerned with LOCAL operation of the Model 351, details are not included in this manual except for the listing of their configuration parameters under "Local Instrument Link Parameters". Details on these functions along with a complete listing of the 46 channels of the transmitted data, parameters that can be requested and changed (e.g. "controller tuning"), and other Link Interface commands can be found in AD351-40, "Model 351 TLDC Link Interface Communications User's Manual".

### Transmitted Data

<table>
<thead>
<tr>
<th>Input</th>
<th>Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3P</td>
<td>18</td>
</tr>
<tr>
<td>L3S</td>
<td>19</td>
</tr>
<tr>
<td>L3V</td>
<td>20</td>
</tr>
<tr>
<td>L3A</td>
<td>35</td>
</tr>
<tr>
<td>L3B</td>
<td>38</td>
</tr>
</tbody>
</table>

### Received Data

<table>
<thead>
<tr>
<th>Output</th>
<th>Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>370</td>
<td>45</td>
</tr>
<tr>
<td>371</td>
<td>46</td>
</tr>
</tbody>
</table>

### LOCAL INSTRUMENT LINK PARAMETERS (EXTERNAL)

The following Model 351 information are configuration parameters for external devices of a Local Instrument Link (e.g. computers, control consoles, etc.). These parameters cannot be configured at the faceplate of the Model 351.

| A | A | 1 | L | CHANNEL L3A ALARM #1 LIMIT | .33 to 103.3% |
| A | A | 2 | L | CHANNEL L3A ALARM #2 LIMIT | .33 to 103.3% |
| A | A | 3 | L | CHANNEL L3A ALARM #3 LIMIT | .33 to 103.3% |
| A | A | 4 | L | CHANNEL L3A ALARM #4 LIMIT | .33 to 103.3% |
| B | A | 1 | L | CHANNEL L3B ALARM #1 LIMIT | .33 to 103.3% |
| B | A | 2 | L | CHANNEL L3B ALARM #2 LIMIT | .33 to 103.3% |
| B | A | 3 | L | CHANNEL L3B ALARM #3 LIMIT | .33 to 103.3% |
| B | A | 4 | L | CHANNEL L3B ALARM #4 LIMIT | .33 to 103.3% |
| A | A | 1 | T | CHANNEL L3A ALARM #1 TYPE WORD | ATW |
| A | A | 2 | T | CHANNEL L3A ALARM #2 TYPE WORD | ATW |
| A | A | 3 | T | CHANNEL L3A ALARM #3 TYPE WORD | ATW |
| A | A | 4 | T | CHANNEL L3A ALARM #4 TYPE WORD | ATW |
| B | A | 1 | T | CHANNEL L3B ALARM #1 TYPE WORD | ATW |
| B | A | 2 | T | CHANNEL L3B ALARM #2 TYPE WORD | ATW |
| B | A | 3 | T | CHANNEL L3B ALARM #3 TYPE WORD | ATW |
| B | A | 4 | T | CHANNEL L3B ALARM #4 TYPE WORD | ATW |

ATW - Alarm Type Word is a 12-bit word that defines the alarm type. Details on each type word can be found in the Model 351 Link Communications User's Manual AD351-40.
Function Block FB199 is reserved for a third, optional input for Loop 1 of the Model 351 and can be selected for:
- Voltage
- Computer Pulse
- Millivolt or Thermocouple
- RTD
- Frequency

The following pages list information about each of these function blocks.

**NOTE:** These function blocks include default configuration parameters that may differ from default parameters of other blocks. It is important to check and/or change all default parameters of FB199 after installation of an optional input board or any time an FCO is stored.
This function block converts an analog voltage with a range defined during calibration into a 0–100% block output for interconnection to other function blocks.

Also included is a digital filter that can be used to filter out process noise and a square root extractor for linearizing a flow signal from a ΔP transmitter.

Calibration details can be found in Instruction SD351 which is included in Section 4 of this manual.

Specifications
Type: Single-ended
Accuracy: 0.05%
Zero and Span: 0 to 1.0 Vdc and 4 to 5 Vdc
Normal Mode Rejection: 6 db at 2 Hz, 60 db at 60 Hz
Input Impedance: Greater than 1 megohm
Max. Continuous Input: ±30 Vdc
Temperature Effect: less than ±0.5% change in span in a 100°F ambient

Output Identification
FB199
Output: 133

Terminal Designations
FB199: A13+ (A10)
A1C- (A9)

---

BLOCK DIAGRAM

---

1 Used with Computer Pulse input only.
Optional Input, Computer Pulse

Applications such as Computer-Set Supervisory, Direct Digital Control (DDC), etc. can be implemented with a Model 351 with this optional input board and function block. This block provides a 0–100% output to other blocks upon an incoming pulse. The output can be incremented either up or down by input pulses which can be selected with hardware jumper plugs for either Dual Pulse or Pulse Direction formats. The block output can also be made to track input T when input C goes high.

Configuration consists of selecting the hardware jumper on the board for either Dual Pulse or Pulse Direction, determining full scale pulses, and selecting the Track (T) and Track Command inputs.

Specifications
Input Voltage: ON = 5–30 Vdc, OFF ≤ 0.5 Vdc
Max. Frequency: 5000 Hz
Min. Pulse Width: 100 msec.
Isolation: Input to be isolated up to 100 Vdc from station common
Max. Continuous Input: ±30 Vdc
Temperature Effect: less than ±0.5% change in span in a 100°F ambient

Output Identification
FB199
Output: 133

Terminal Designations
FB199: Pl+ (A10)
Pl− (B10)
PIC (A9)

Pulse/Digital Converter

Dual Pulse
Pulse Direction

Pulse Input Board

Block Diagram

(continued on next page)
This function block converts a low level analog voltage (millivolt/thermocouple) into a 0–100% block output for interconnection to other function blocks.

There are two hardware jumpers on the PC board. J1 determines if the range is wide (allows C37 selections 1–4) or narrow (allows C37 selections 5–9). J2 selects UPSCALE or DOWNSCALE drive on an open circuit input.

Once the hardware jumpers have been selected a range type can be picked in the calibration configuration mode C37. The input would then be calibrated for the range type selected. (E.g., if 2 (J) is picked the input would be calibrated for a thermocouple range of 0–1700°F.) Details on calibration can be found in Instruction SD351 included in Section 4 of this manual.

A unique feature of this input card is the highly accurate 16-bit autoscaling A/D Converter. Since the block output of 0–100% is represented by a 12-bit value the user can select, during soft configuration, the actual millivolt or temperature range to be represented by the 0–100% 12-bit value.

**Output Identification**

**FB199**

Output: 133

**Terminal Designations**

FB199: A13+ (A10)
A13– (B10)
A13E (A9)

---

**FB199**

**OPTIONAL INPUT, MILLIVOLT OR THERMOCOUPLE**

- **T/C LINEARIZATION**
- **T/C COMPENSATION**
- **CALIBRATION Z13 & F13**
- **RANGE SCALER RL & RH**
- **DIGITAL FILTER FB3**

**FILTER BREAKPOINT**

- **S** - 0.001 to 10.00 Hz
- **R** - RANGE UNITS 1. MV/2°F/3°C
- **U** - RANGE LOW
- **H** - RANGE HIGH
- **Z** - ZERO INPUT
- **F** - FULL SCALE INPUT
- **V** - VERIFY INPUT
- **I** - INPUT 3 TYPE
- **T** - INPUT T
- **C** - INPUT C

**RANGE TABLE**

<table>
<thead>
<tr>
<th>COST</th>
<th>C01</th>
<th>C02</th>
<th>ORIGIN</th>
<th>S/P</th>
<th>P/RANGE</th>
<th>SPAN RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.000</td>
<td>75.00</td>
<td>75.00</td>
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<td>2</td>
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</tr>
<tr>
<td>4</td>
<td>120</td>
<td>120</td>
<td>120.00</td>
<td>120.00</td>
<td>120.00</td>
<td>120.00</td>
</tr>
</tbody>
</table>

**BLOCK DIAGRAM**

(continued on next page)
This function block converts a resistance range from a Platinum RTD to a 0–100% block output for interconnection to other blocks.

The RTD input is linearized using either the DIN or US curves.

A unique feature of this input card is the highly accurate 16-bit autoscaling A/D converter. Since the block output of 0–100% is represented by a 12-bit value, the user can select during soft configuration the actual resistance range to be represented by the 0–100% 12-bit value.

**Specifications**

Type: 100 Ohms, Platinum, DIN or US

Range Limits: -300°F to 1200°F (-185°C to 650°C)

Range Low: -300°F to 800°F (-185°C to 425°C)

Range High: -275°F to 1200°F (-171°C to 650°C)

Lead Resistance Effect: 0.01°F/Ohm

Accuracy: ±0.1% of span for a > 100°F; ±0.1°F for a span < 100°F

**Output Identification**

FB199

Output: 133

**Terminal Designations**

FB199: A13+ (A10)

A13– (B10)

A13E (A9)

---

**BLOCK DIAGRAM**

---

(continued on next page)
Frequency inputs to a Model 351 can be implemented with this optional input board and function block. This input can accept sine, square, pulse, or triangle waveforms at frequencies between 0.05 Hz and 25.0 kHz with amplitudes from 4.0V to 60.0V, peak-to-peak. It can also accept contact closure inputs at a maximum frequency of 100 Hz.

The input frequency is converted to a 0–100% value for use by other blocks. The Frequency Input block features a selectable LEARN mode to determine waveform peak and valley, or direct entry when these values are known. When LEARN is selected, the board automatically samples the input to set the CIPV and CIVV parameters. Input peak and valley, as well as the LEARN selection, are defined during calibration of the controller. Refer to SD351 for calibration information.

Configuration consists of selecting the minimum and maximum frequency ranges, zero dropout percent of range, and using the block's output identification as an input to other blocks.

**Specifications**

Frequency Range: 0–1 Hz to 0–25,000 Hz
Zero: 0–10,000 Hz
Span: 1–25,000 Hz (span must be greater than 1X zero frequency
Operating Frequency: 0.05 Hz (minimum)
Signal Types: Sine, Square, Pulse, Triangle, or Contact Closure
Pulse Width: 20.0 μsec (minimum)
Signal Amplitude: 4–60 Vac, peak-to-peak
Note: The DC offset voltage plus 0.5 times the peak-to-peak AC voltage cannot exceed 30V.

**Output Identification**

FB199
Output: 133

**Terminal Designations**

FB199: A13+ (A10)
A13C (B10)