GE Motors & Industrial Systems

LCI AUXILIARY I/O TERMINAL BOARD

DS200DDTBG_A_ _

These instructions do not purport to cover all details or variations in equipment, nor to provide every possible contingency to be met during installation, operation, and maintenance. If further information is desired or if particular problems arise that are not covered sufficiently for the purchaser's purpose, the matter should be referred to GE Motors & Industrial Systems.

CONTENTS

SAFETY SYMBOL LEGEND

WARNING — Indicates a procedure, practice, condition, or statement that, if not strictly observed, could result in personal injury or death.

CAUTION — Indicates a procedure, practice, condition, or statement that, if not strictly observed, could result in damage to or destruction of equipment

NOTE Indicates an essential or important procedure, practice, condition, or statement.

FUNCTIONAL DESCRIPTION

INTRODUCTION

The DS200DDTB board (DDTB) is a high voltage terminal board for system connections of auxiliary I/O signals. The board connects to a DS200ADMA (ADMA) analog-to-digital module daughterboard that is mounted on a DS200DSPC (DSPC) digital signal processor control board. High density connectors and a ribbon cable connect the DDTB to the ADMA board. Power for the DDTB is provided by the ADMA board. The DDTB provides signal conditioning, scaling, buffering, and isolation to make the harsh environment system level signals accessible to the DSPC board's digital signal processor (DSP). External wiring connections from high voltage signals, contact I/O, current measurement (via low level Hall-effect devices), or high current CTs can be connected to the DDTB terminals. There are G1 and G2 versions of the DDTB board. The G2 lacks some of the functionality of the G1 and is noted where applicable.

GENERAL FEATURES

Electronic Board Identification

An add-only electronic ID memory is provided on the DDTB that contains board identification and hardware revision information. This memory is accessed through a 1-wire LAN and allows the DSPC board to electronically identify boards that are present in a system. This information is read and reported during power-up. The DSPC board hosts the ID interface for reading, but it cannot alter the ID information.

Analog Inputs

HIGH VOLTAGE AC INPUTS. There are two isolated inputs for connection to high voltage ac signals. These use a step-down transformer, passive filtering, and a buffer to provide a ±5 V peak-to-peak signal to the ADMA board's VCO inputs (at 693 V rms applied). These inputs have a separate screw terminal block rated and isolated for 1000 V peak transients.

HIGH CURRENT SIGNAL INPUTS. There are six inputs with current sensing resistors suitable for ±5 amp continuous current signals (intended for CT inputs). These are buffered differentially and can tolerate ±12 V of common mode voltage. Each input is filtered and scaled. These inputs have a screw type terminal block and are protected from voltage surges.

LOW CURRENT SIGNAL INPUTS. There are three inputs with current sensing resistors suitable for ±0.224 amp continuous current signals (intended for LEM current transducer signals). These are buffered differentially and can tolerate ±12 V of common mode voltage. Each input is filtered and scaled. These inputs have a screw type terminal block and are protected from voltage surges.

4-20 mA CURRENT LOOP INPUTS. There are provisions for reassigning two of either the CT or LEM input chanels as receivers for 4-20 mA current loop input signals. This alternate assignment is made by resetting certain jumpers. The input resistance is 192 ohms and the analog input is offset so that 0 mA yields negative full scale and 20 mA yields positive full scale. Open loop detection and input normalization is managed by software.

UNDEDICATED VOLTAGE INPUTS. A differential input voltage amplifier is provided for feeding an analog VCO input on the ADMA board. The gain of this amplifier is 1/2 allowing a ±10 V input signal range. These inputs have a screw type terminal block and are protected from voltage surges.

Analog Outputs

VOLTAGE OUTPUTS. There are four buffered analog outputs available at screw terminals. These include a gain of two to provide a ±10 V output range from the ±5 V range output signal from the ADMA board. Each output has a 200 ohm series resistor to isolate the amplifier from the customer connection.

4-20 mA CURRENT OUTPUTS. Two of the analog outputs also drive current source output buffers to provide support for the 4-20 mA current loop output signals. Both the voltage and current outputs are active at all times and can be used individually or together by wiring to their respective output terminals. There is an inversion and gain stage in the 4-20 mA driver such that a +5 V input from the ADMA board causes the output to produce 4 mA and a −5 V input causes the output to produce 20 mA. An output is not permitted to produce 0 mA to avoid confusion with open loop detection.

Digital I/O

HIGH CURRENT RELAY OUTPUTS. There are two form C relay outputs rated for 20 amps at 240 V ac or 10 amps at 30 V dc. Both outputs have contacts available on the screw terminals and have an LED indicator that is lit when the relay is picked up. Driven loads must be suppressed externally.

MEDIUM CURRENT RELAY OUTPUTS. There are two form C relay outputs rated for 10 amps at 240 V ac or 7 amps at 30 V dc. Both outputs have contacts available on the screw terminals and have an LED indicator that is lit when the relay is picked up. Driven loads must be suppressed externally.

ISOLATED DISCRETE OUTPUTS. There are four optically isolated solid state outputs rated at 48 V maximum, 10 mA each. Each output is available on a pair of screw terminals and has an LED indicator that is lit when the output is ON (conductive).

UNIVERSAL ISOLATED DISCRETE INPUTS. There are eight optically isolated universal inputs that will respond to 24–250 V dc / 24–230 V ac at 60 Hz, or 125–230 V ac at 50 Hz signals. Each input is available on a pair of screw terminals and has an LED indicator that is lit when the input has voltage present.

APPLICATION DATA

LEDS

There are 17 LEDs (DS1–DS17) located on the DDTB (see Figure 1 for location). One of these LEDs indicate DDTB board status while the others are hardware and software driven. See Table 1 for a full description of all LEDs.

TESTPOINTS

There are 33 testpoints (TP1−TP33) located on the DDTB board (see Figures 1 and 2 for location). These testpoints can be used for signal measurement purposes as described in Table 2.

CONNECTORS

The connectors that are located on the DDTB board are shown in Table 3 (with a brief description of signals). See Figure 1 for location.

The individual pin signals for each of the connectors are shown in Tables 4 through 9. Connector TBPL is for connecting the ADMA daughterboard.

JUMPERS

There are 12 3-pin row type jumpers furnished on the DDTB board (see Figure 1). These jumpers are for reassigning the CT and LEM input channels to become inputs for 4-20 mA current loop signals. The individual function and setting for each of the jumpers is shown in Table 10. The factory default position for all jumpers is the 1-2 position.

Table 1. DDTB Board LEDs

Designation	Color	Description
DS1	Red	Digital input signal #1 active state indicator (on when active)
DS2	Red	Digital input signal #2 active state indicator (on when active)
DS3	Red	Digital input signal #3 active state indicator (on when active)
DS4	Red	Digital input signal #4 active state indicator (on when active)
DS5	Red	Digital input signal #5 active state indicator (on when active)
DS6	Red	Digital input signal #6 active state indicator (on when active)
DS7	Red	Digital input signal #7 active state indicator (on when active)
DS8	Red	Digital input signal #8 active state indicator (on when active)
DS9	Red	Digital output signal #1 active state indicator (on when active)
DS10	Red	Digital output signal #2 active state indicator (on when active)
DS11	Red	Digital output signal #3 active state indicator (on when active)
DS12	Red	Digital output signal #4 active state indicator (on when active)
DS13	Red	Digital output signal #5 active state indicator (on when active)
DS14	Red	Digital output signal #6 active state indicator (on when active)
DS15	Red	Digital output signal #7 active state indicator (on when active)
DS16	Red	Digital output signal #8 active state indicator (on when active)
DS17	Green*	Indicates that the board is functioning properly

This LED will be off when the DSPC board is performing a **loop back test of the DDTB/ADMA board set.*

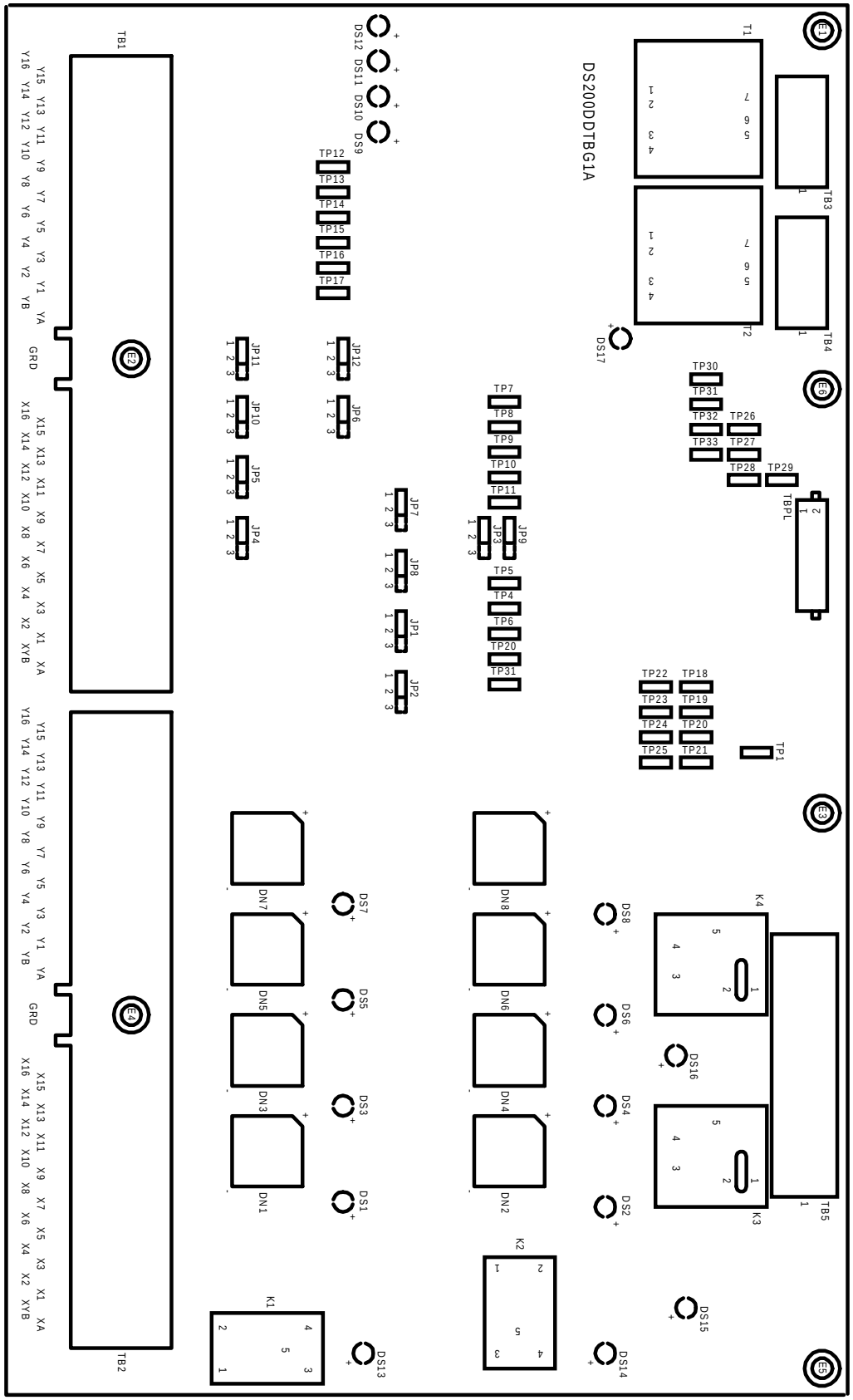

Figure 1. DDTB Board Layout

Table 2. DDTB Board Testpoints

Testpoint	Description
TP1	Signal common
TP2	Input to ADMA board VCO #0 (high voltage input #1)
TP3	Input to ADMA board VCO #1 (high voltage input #2)
TP4	Input to ADMA board VCO #2 (undedicated voltage input)
TP5*	Input to ADMA board high speed A/D #0 (CT input #1)
TP6*	Input to ADMA board high speed A/D #1 (CT input #2)
TP7*	Input to ADMA board high speed A/D #2 (CT input #3)
TP8*	Input to ADMA board high speed A/D #3 (CT input #4)
TP9	Input to ADMA board high speed A/D #4 (CT input #5 / 4-20 mA #1)
TP10	Input to ADMA board high speed A/D #5 (LEM input #1 / 4-20 mA #2)
TP11*	Input to ADMA board high speed A/D #6 (CT input #6 / 4-20 mA #1)
TP12*	Input to ADMA board high speed A/D #7 (LEM input #2 / 4-20 mA #2)
TP13*	Input to ADMA board high speed A/D #8 (LEM input #3)
TP14	Analog output #1
TP15	Analog output #2
TP16	Analog output #3
TP17	Analog output #4
TP18	Digital input #1
TP19	Digital input #2
TP20	Digital input #3
TP21	Digital input #4
TP22	Digital input #5
TP23	Digital input #6
TP24	Digital input #7
TP25	Digital input #8
TP26	Digital output #1
TP27	Digital output #2
TP28	Digital output #3
TP29	Digital output #4
TP30	Digital output #5
TP31	Digital output #6
TP32	Digital output #7
TP33	Digital output #8

**These testpoints and the associated functions are not available on G2 version DDTB boards.*

Table 3. DDTB Board Connectors

Connector	Description	Type
TB1 and TB2	Analog inputs that include the following signals: 2 undedicated differential amplifier inputs (±10 V VCO), 6 CT inputs, 3 LEM inputs, 2 4-20 mA current loop inputs, 2 analog outputs & returns, 2 4-20 mA current loop outputs, 8 isolated universal discrete inputs, 4 isolated discrete outputs, 2 10 amp form C relay contacts, and 6 chassis grounds (shields)	36-Position, Double Row
TB3	High voltage inputs for VCO 0	3-Position, Terminal Strip and Clamp
TB4	High voltage inputs for VCO 1	3-Position, Terminal Strip and Clamp
TB5	2 - 20 amp form C relay contact terminals	6-Position, Terminal Strip and Clamp
TBPL	Interface to ADMA daughter board that includes the following pin signals: 8 discrete logic outputs, 8 discrete logic inputs, 4 +5 V logic power outputs, 20 COM (and shields), 2 +12 to +15 V dc analog power outputs, 2 –12 to –15 V dc analog power outputs, 4 analog outputs, 9 sampled analog inputs, and 3 analog inputs to	60-pin high density ribbon cable header

Table 4. TB1 Pin Descriptions

Pin #	Signal	Description
1-XA	CT6+	Current Transformer #6 positive (+) input
1-XB	CT6–	Current Transformer #6 negative (–) input
1-X1	IL1IN+	4-20 mA current loop input #1, positive (+)
1-X2	IL1IN–	4-20 mA current loop input #1, negative (–)
1-X3	IL2IN+	4-20 mA current loop input #2, positive (+)
1-X4	IL2IN–	4-20 mA current loop input #2, negative (–)
1-X5	VIN–	Undedicated voltage input, negative (–)
1-X6	VIN+	Undedicated voltage input, positive (+)
1-X7	LEM1+	LEM current sensor #1 input, positive (+)
1-X8	LEM1–	LEM current sensor #1 input, negative (–)
1-X9	LEM2+	LEM current sensor #2 input, positive (+)
1-X10	LEM2–	LEM current sensor #2 input, negative (–)
1-X11	LEM3+	LEM current sensor #3 input, positive (+)
1-X12	LEM3–	LEM current sensor #3 input, negative (–)
1-X13	AOUT1	Analog output #1
1-X14	ACOM	Analog common for AOUT1
1-X15	IL1OUT+	4-20 mA current loop output #1, positive (+)
1-X16	IL1OUT–	4-20 mA current loop output #1, negative (–)
GRD	GRD	Ground

Table 4. TB1 Pin Descriptions — Continued

Pin #	Signal	Description
1-YA	AOUT2	Analog output #2
1-YB	ACOM	Analog common for AOUT2
1-Y1	IL2OUT+	4-20 mA current loop output #2, positive (+)
1-Y2	IL2OUT–	4-20 mA current loop output #2, negative (–)
1-Y3	AOUT3	Analog output #3
1-Y4	ACOM	Analog common for AOUT3
1-Y5	AOUT4	Analog output #4
1-Y6	ACOM	Analog common for AOUT4
1-Y7	GND	Sheetmetal ground
1-Y8	GND	Sheetmetal ground
1-Y9	DOUT1+	Digital output #1, positive (+)
1-Y10	DOUT1–	Digital output #1, negative (–)
1-Y11	DOUT2+	Digital output #2, positive (+)
1-Y12	DOUT2–	Digital output #2, negative (–)
1-Y13	DOUT3+	Digital output #3, positive (+)
1-Y14	DOUT3–	Digital output #3, negative (–)
1-Y15	DOUT4+	Digital output #4, positive (+)
1-Y16	DOUT4–	Digital output #4, negative (–)

Table 5. TB2 Pin Descriptions

Pin #	Signal	Description
2-XA	K2-CMN	Digital output #6 relay (K2) common lead
2-XB	K1-CMN	Digital output #5 relay (K2) common lead
2-X1	K2-NO	Digital output #6 relay (K2) normally open contact
2-X2	K1-NO	Digital output #5 relay (K2) normally open contact
2-X3	K2-NC	Digital output #6 relay (K2) normally closed contact
2-X4	K1-NC	Digital output #5 relay (K2) normally closed contact
2-X5	GND	Sheetmetal ground
2-X6	GND	Sheetmetal ground
2-X7	DIN1+	Digital input #1, positive (+)
2-X8	DIN1–	Digital input #1, negative (–)
2-X9	DIN2+	Digital input #2, positive (+)
2-X10	DIN2–	Digital input #2, negative (–)
2-X11	DIN3+	Digital input #3, positive (+)
2-X12	DIN3–	Digital input #3, negative (–)
2-X13	DIN4+	Digital input #4, positive (+)
2-X14	DIN4–	Digital input #4, negative (–)
2-X15	DIN5+	Digital input #5, positive (+)
2-X16	DIN5–	Digital input #5, negative (–)
GRD	GRD	Ground

Table 5. TB2 Pin Descriptions — Continued

Pin #	Signal	Description
2-YA	DIN6+	Digital input #6, positive (+)
2-YB	DIN6–	Digital input #6, negative (–)
2-Y1	DIN7+	Digital input #7, positive (+)
2-Y2	DIN7–	Digital input #7, negative (–)
2-Y3	DIN8+	Digital input #8, positive (+)
2-Y4	DIN8–	Digital input #8, negative (–)
2-Y5	GND	Sheetmetal ground
2-Y6	GND	Sheetmetal ground
2-Y7	CT1+	Current transformer #1 input, positive (+)
2-Y8	CT1–	Current transformer #1 input, negative (–)
2-Y9	CT2+	Current transformer #2 input, positive (+)
2-Y10	CT2–	Current transformer #2 input, negative (–)
2-Y11	CT3+	Current transformer #3 input, positive (+)
2-Y12	CT3–	Current transformer #3 input, negative (–)
2-Y13	CT4+	Current transformer #4 input, positive (+)
2-Y14	CT4–	Current transformer #4 input, negative (–)
2-Y15	CT5+	Current transformer #5 input, positive (+)
2-Y16	CT5–	Current transformer #5 input, negative (–)

Table 6. TB3 Pin Descriptions

Pin #	Signal	Description
P3-1	PT1P	Positive high voltage input for VCO 0
P3-2	N/C	Not connected
P3-3	PT1N	Negative high voltage input for VCO 0

Table 7. TB4 Pin Descriptions

Pin #	Signal	Description
P4-1	PT2P	Positive high voltage input for VCO 1
P4-2	N/C	Not connected
P4-3	PT2N	Negative high voltage input for VCO 1

Table 8. TB5 Pin Descriptions

Pin #	Signal	Description
P5-1	K6-NO	Form C relay (K6) normally open contact
P5-2	K6-CMN	Form C relay (K6) common lead
P5-3	K6-NC	Form C relay (K6) normally closed contact
P5-4	K4-NO	Form C relay (K4) normally open contact
P5-5	K4-CMN	Form C relay (K4) common lead
P5-6	K4-NC	Form C relay (K4) normally closed contact

Table 9. TBPL Interface Port Pin Descriptions

Pin #	Signal	Description
TBPL-1	DCOM	Digital common
TBPL-2	DO1	Digital output #1
TBPL-3	DO2	Digital output #2
TBPL-4	DCOM	Digital common
TBPL-5	DO3	Digital output #3
TBPL-6	DO4	Digital output #4
TBPL-7	DCOM	Digital common
TBPL-8	DO5	Digital output #5
TBPL-9	DO6	Digital output #6
TBPL-10	DCOM	Digital common
TBPL-11	DO7	Digital output #7
TBPL-12	DO8	Digital output #8
TBPL-13	DCOM	Digital common
TBPL-14	DI1	Digital input #1
TBPL-15	DI2	Digital input #2
TBPL-16	DCOM	Digital common
TBPL-17	DI3	Digital input #3
TBPL-18	DI4	Digital input #4
TBPL-19	DCOM	Digital common
TBPL-20	DI5	Digital input #5
TBPL-21	DI6	Digital input #6
TBPL-22	DCOM	Digital common
TBPL-23	DI7	Digital input #7
TBPL-24	DI8	Digital input #8
TBPL-25	DCOM	Digital common
TBPL-26	IDDATA	Identification memory access line
TBPL-27	0TBOK	Terminal board OK interlock
TBPL-28	P5	Positive (+) 5 V dc
TBPL-29	AOUT1	Analog output #1
TBPL-30	P5	Positive (+) 5 V dc

Table 9. TBPL Interface Port Pin Descriptions — Continued

Pin #	Signal	Description
TBPL-31	AOUT2	Analog output #2
TBPL-32	P5	Positive (+) 5 V dc
TBPL-33	AOUT3	Analog output #3
TBPL-34	P5	Positive (+) 5 V dc
TBPL-35	AOUT4	Analog output #4
TBPL-36	P5	Positive (+) 5 V dc
TBPL-37	HSAD0	Analog input to high speed sampled ADC #0
TBPL-38	P5	Positive (+) 5 V dc
TBPL-39	HSAD1	Analog input to high speed sampled ADC #1
TBPL-40	P5	Positive (+) 5 V dc
TBPL-41	HSAD2	Analog input to high speed sampled ADC #2
TBPL-42	P5	Positive (+) 5 V dc
TBPL-43	HSAD3	Analog input to high speed sampled ADC #3
TBPL-44	P5	Positive (+) 5 V dc
TBPL-45	HSAD4	Analog input to high speed sampled ADC #4
TBPL-46	N15	Negative (–) 15 V dc
TBPL-47	HSAD5	Analog input to high speed sampled ADC #5
TBPL-48	N15	Negative (–) 15 V dc
TBPL-49	HSAD6	Analog input to high speed sampled ADC #6
TBPL-50	P15	Positive (+) 15 V dc
TBPL-51	HSAD7	Analog input to high speed sampled ADC #7
TBPL-52	P15	Positive (+) 15 V dc
TBPL-53	HSAD8	Analog input to high speed sampled ADC #8
TBPL-54	ACOM	Analog common
TBPL-55	AVCO0	Analog input to VCO #0
TBPL-56	ACOM	Analog common
TBPL-57	AVCO1	Analog input to VCO #1
TBPL-58	ACOM	Analog common
TBPL-59	AVCO2	Analog input to VCO #2
TBPL-60	ACOM	Analog common

Table 10. Configurable Jumper Descriptions

Jumper #	Position	Description
JP1*	1-2: 2-3	ADMA high speed A/D converter #4 input = Current transformer (CT) #5 ADMA high speed A/D converter #4 input = Current loop (IL) #1
JP2*	1-2: 2-3:	ADMA high speed A/D converter #4 input = Current transformer (CT) #5 ADMA high speed A/D converter #4 input = Current loop (IL) #1
JP3*	1-2: 2-3:	ADMA high speed A/D converter #4 input = Current transformer (CT) #5 ADMA high speed A/D converter #4 input = Current loop (IL) #1
JP4**	1-2: 2-3:	ADMA high speed A/D converter #6 input = LEM #1 ADMA high speed A/D converter #6 input = Current loop (IL) #1
JP5**	1-2: 2-3:	ADMA high speed A/D converter #6 input = LEM #1 ADMA high speed A/D converter #6 input = Current loop (IL) #1
JP6**	1-2: 2-3:	ADMA high speed A/D converter #6 input = LEM #1 ADMA high speed A/D converter #6 input = Current loop (IL) #1
JP7***	1-2: 2-3:	ADMA high speed A/D converter #5 input = Current transformer (CT) #6 ADMA high speed A/D converter #5 input = Current loop (IL) #2
JP8***	1-2: 2-3:	ADMA high speed A/D converter #5 input = Current transformer (CT) #6 ADMA high speed A/D converter #5 input = Current loop (IL) #2
JP9***	1-2: 2-3:	ADMA high speed A/D converter #5 input = Current transformer (CT) #6 ADMA high speed A/D converter #5 input = Current loop (IL) #2
JP10****	1-2: 2-3:	ADMA high speed A/D converter #7 input = LEM #2 ADMA high speed A/D converter #7 input = Current loop (IL) #2
JP11****	1-2: 2-3:	ADMA high speed A/D converter #7 input = LEM #2 ADMA high speed A/D converter #7 input = Current loop (IL) #2
JP12****	1-2: 2-3:	ADMA high speed A/D converter #7 input = LEM #2 ADMA high speed A/D converter #7 input = Current loop (IL) #2

* *JP1, JP2, and JP3 must be set in the same position.*

** *JP4, JP5, and JP6 must be set in the same position. These jumpers and the associated functions are not available on G2 version DDTB boards.*

*** *JP7, JP8, and JP9 must be set in the same position.*

**** *JP10, JP11, and JP12 must be set in the same position. These jumpers and the associated functions are not available on G2 version DDTB boards.*

RENEWAL/WARRANTY REPLACEMENT

BOARD PART NUMBER IDENTIFICATION

A printed wiring board is identified by an alphanumeric part (catalog) number stamped on its edge. For example, the DDTB is identified by part number DS200DDTBG#. Figure 2 describes each digit in the part number.

NOTE

All digits are important when ordering or replacing any board.

WARRANTY TERMS

The GE Motors & Industrial Systems Terms and Conditions brochure details product warranty information, including the **warranty period** and **parts and service** coverage.

The brochure is included with customer documentation. It may able be obtained separately from the nearest GE Sales Office or authorized GE Sales Representative.

WARRANTY PARTS AND SERVICE

This board has no fuses or other end-user serviceable parts. If it fails, it needs to be replaced as a unit. To obtain a replacement board, or service assistance, contact the nearest GE Service Office.

Please have the following information ready to exactly identify the **part** and **application**:

- GE requisition or shop order number
- LCI serial number and model number
- Board number and description

PROCEDURE FOR REPLACING BOARDS

WARNING

To prevent electric shock, turn off power to the board, then test to verify that no power exists in the board before touching it or any connected circuits.

CAUTION

To prevent equipment damage, do not remove boards or connections, or re-insert them, while power is applied to the drive.

Treat all boards as static-sensitive. Use a grounding strap when changing boards and always store boards in anti-static bags or boxes they were shipped in.

To replace a DDTB board: (see Figure 1).

1. **Turn off power**.
2. Locate the DDTB inside the control cabinet, mounted below the VME rack assembly.
3. Carefully disconnect all cables connected to the DDTB board as follows:
   - For ribbon cables, grasp each side of the cable connector that mates with the board connector,press the retaining clips inward, and gently pull the cable connector loose.
   - For cables with pull tabs, carefully pull the tab.
   - For individual wires, loosen/remove the screw securing the wire lug to the respective terminal and remove the wire from the terminal. Always mark the wires (if they are not already) for what terminal they are to be reconnected to on the new DDTB.
4. Remove the four screws with washers that secure the DDTB board to the support bracket standoffs and set them aside.

CAUTION

Avoid dropping any hardware into the control cabinet, which could cause damage.

5. Carefully remove the DDTB from the two clip standoffs that are still securing it to the bracket.
6. Set all hardware jumpers on the new DDTB board in the same position as on the DDTB board that was removed.

7. Install the new DDTB board onto the standoffs by carefully aligning the two clip type standoffs with the mounting holes provided in the board and pushing the board into position on the clips.

8. Secure the new DDTB board to support bracket standoffs with the four screws removed in step 4.

9. Reconnect all cables that were disconnected in step 3. Ensure that each connector is properly seated and that all screw connections are fully tightened.

NOTE

Because of upgrades, boards of different revision levels may not contain identical hardware. However, GE Motors & Industrial Systems ensures backward compatibility of replacement boards.

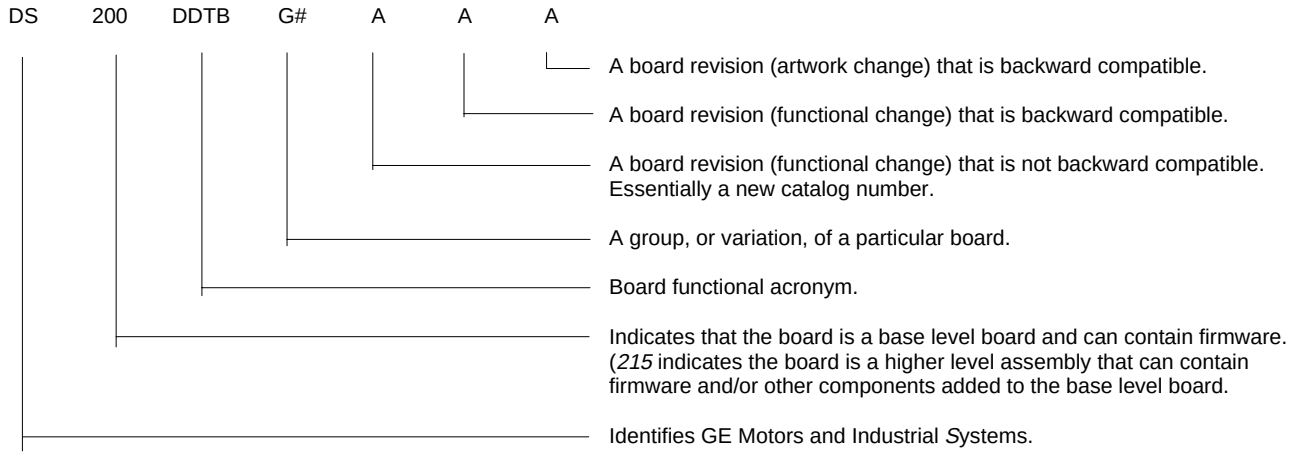

Figure 2. Sample Board Part Number, DS Series

Notes:

GE Motors & Industrial Systems

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