Carter CAT **Service Information System** Shutdown SIS

Previous Screen

Product: NO EQUIPMENT SELECTED
Model: NO EQUIPMENT SELECTED
Configuration: NO EQUIPMENT SELECTED

Systems Operation
Digital Voltage Regulator
Media Number -SENR5833-07 **Publication Date -01/02/2009** **Date Updated -11/02/2009**

i03470351

Parameters

SMCS - 4467

Parameter Table

Table 1

PARAMETERS					
Parameter	**Title**	**Type**	**Units**	**Range of Value**	**Default Value**
01	Generator Output Voltage	Program	Volts	0080 - 9999	0480 (1)
02 (2)	Ratio Of Output Voltage To Sensing Voltage	Program	-	001.0 - 100.0	001.0
03	Generator Type	Program	-	0000 - 0004	0004
04	Rated Generator Output Current	Program	Amps	0000 - 9999	0600
05 (2)	CT Voltage At Rated Generator Current	Program	Volts	01.00 - 05.00	05.00
06	Knee Frequency	Program	Hz	045.0 - 065.0	050.0
07	Decreasing Volts/Hz Slope 1	Program	Volts/Hz	001.0 - 010.0	002.0
08	Decreasing Volts/Hz Slope 2	Program	Volts/Hz	001.0 - 010.0	002.0

09	Minimum Voltage	Program	%	050.0 - 100.0	050.0
10	Underfrequency Point	Program	Hz	020.0 - 040.0	025.0
11	Overvoltage Trip Point	Program	%	0105 - 0140	0140
12	Overvoltage Trip Time	Program	Seconds	0002 - 0030	0002
13	Undervoltage Trip Point	Program	%	0060 - 0095	0060
14	Undervoltage Trip Time	Program	Seconds	0030 - 0120	0030
15	Voltage Gain (IR Compensation)	Program	%	000.0 - 010.0	0000
16 (3)	Integral Gain	Program	-	001.0 - 020.0	006.0
17 (4)	Proportional Gain	Program	-	001.0 - 020.0	005.0
18	Single Phase Sensing Select (0 = three-phase, 1 = single phase)	Program	-	0000, 0001	0000
19	Diode Monitor Trip Point	Program	Amps	001.0 - 010.0	002.0
20	Reverse VAR Trip Time	Program	Seconds	000.1 - 009.9	000.5
21	Reverse VAR Fault Selection	Program	-	0000 - 0002	0002
22	Droop/CCC Select (0 = Droop, 1 = CCC)	Program	-	0000, 0001	0000
30	Droop Percentage	Program	%	000.0 - 010.0	0000
31 (5)	PF/KVAR Select (0 = PF, 1 = KVAR)	Program	-	0000, 00001	0000
32 (5)	PF Reference	Program	-	00.60 - 01.10	01.00
33 (5)	KVAR Reference	Program	Per Unit	00.00 - 01.00	0000

34	Reverse Power Trip Point	Program	%	000.0 - 020.0	010.0
35	Reverse Power Trip Time	Program	Seconds	000.0 - 020.0	010.0
36 [5]	Paralleling Integral Gain	Program	-	000.1 - 030.0	003.3
37 [5]	Paralleling Proportional Gain	Program	-	000.1 - 009.9	001.3
38 [5]	PF Switch Point	Program	%	0010 - 0025	0015
50	Generator Output Frequency	View	Hz	-	-
51	Generator Output Voltage	View	Volts	-	-
52	Generator Output Current	View	Amps	-	-
53	Generator Reactive Output Current	View	Amps	-	-
54	Generator Real Current	View	Amps	-	-
55	Exciter Field Current	View	Amps	-	-
56 [5]	Three-Phase Kilowatts ("KE" and later)	View	kW	-	-
57 [5]	Power Factor (PF)	View	-	-	-
58 [5], [6]	Three-Phase KVAR ("KE" and later)	View	-	-	-
60	Hours	View	Hours	-	-
70 [5], [7]	Voltage Adjust	View	-	0000 - 0200	0100
71 [5], [7]	PF/KVAR Adjust	View	-	0000 - 0200	0100
90	Password	Program	-	0000 - 9999	0200
91	Software ID	View	-	-	-
92	Latest Fault	View	-	-	0000
93	Previous Fault	View	-	-	0000
94	Fault Clear	Switch	-	-	-

95 (8)	Alarm Fault	View	-	-	-
96	Shutdown Fault Reset	Switch	-	-	-

(1) Default value for the output voltage is different depending on the regulator sensing voltage. If the regulator is designed for 120 volts sensing, then the default output voltage is 4160 volts. All other sensing types have the default output voltage set to 480 volts.

(2) Digital voltage regulators with "KD" and earlier software have one less digit to the right of the decimal point.

(3) Earlier versions had a range of 0001-099.9 and default value of 002.0.

(4) Earlier versions had a range of 0001-099.9 and default value of 003.0.

(5) This is an optional feature.

(6) New parameter on serial number prefix "KE" and later digital voltage regulators

(7) The parameter can be adjusted only through the use of the serial link. See System Operation, "Parameters", topic Parameter Descriptions for more details.

(8) The parameter is only available on "KD" and earlier software versions.

General Information

Parameters are pieces of information which are used within the memory of the digital voltage regulator. Each parameter has a specific range of values. Parameters direct the operation of the digital voltage regulator. Service personnel can configure certain parameters to the requirements of a specific site. The configuration changes the value of a particular parameter. There is an upper and a lower limit for the value of each parameter. The limits can not be exceeded.

Not all parameters are configurable. Some parameters are used only to show status. These parameters are used only for viewing or monitoring purposes. Some parameters operate as a switch that activate a specific function of the digital voltage regulator. Parameters :01 through :49 are parameters that can be configured. Parameters :50 through :79 are only a monitor or a view parameter. Parameters :90 through :99 are system parameters. The system parameters are primarily used as alarm and fault parameters for the entire system.

Each parameter is assigned a specific two digit code. These parameters can be shown on the display of the digital voltage regulator. Parameters are preceded by a colon. The value of each parameter can also be shown on the display of the digital voltage regulator. The parameter value is a four digit number. The parameter value is not preceded by a colon.

Proper activation of the keypad is necessary in order to view the parameters. Proper activation of the keypad is necessary in order to configure the values of the parameters. Refer to the System Operation, "Display And Keypad". Also, see Testing And Adjusting, "Parameter Viewing And Configuring Procedure".

Parameter Descriptions

Parameter :01 - Generator Output Voltage The generator output voltage is the voltage that is expected (desired) at the generator output terminals. Modify the generator output voltage parameter in order to adjust the normal generator output voltage. A remote voltage adjust rheostat will provide a ±10% voltage adjustment range from the value that is entered for generator output voltage.

Parameter :02 - Ratio Of Output Voltage To Sensing Voltage This is the ratio of the generator output voltage to the regulator sensing voltage. The generator output voltage appears at the terminals of the generator. The regulator sensing voltage appears at terminals 20, 22, and 24 of the digital voltage regulator. In order to determine the ratio of output voltage to sensing voltage if the generator output is less than 700 VAC, divide the generator output voltage by the voltage range on the digital voltage regulator ID nameplate. The number actually used for the voltage range listed on the digital voltage regulator ID nameplate varies with the frequency (Hz) of the generator. The numbers that are used for the different digital voltage regulator voltage ranges are listed below.

- If the range is 79-124 use 100 volts for 50 Hz or 120 volts for 60 Hz.
- If the range is 125-249, then use 200 volts for 50 Hz or 240 volts for 60 Hz.
- If the range is 250-600, then use 400 volts for 50 Hz or 480 volts for 60 Hz.

For example, if the generator output voltage is 480 volts and the digital voltage regulator voltage range is 125-249 and the frequency of the generator is 60 HZ, then the ratio is 480 divided by 240 which equals 2. The following method may be useful for generators with an output that is below 700 VAC. The usefulness of the following method will depend on the connection diagram that is used.

If the generator output voltage is more than 700 VAC, then use the transformer ratio of the sensing transformers. For example, if the generator output voltage is 4160 VAC and the sensing transformers are 4200:120, the voltage ratio is 35 (4200 divided by 120).

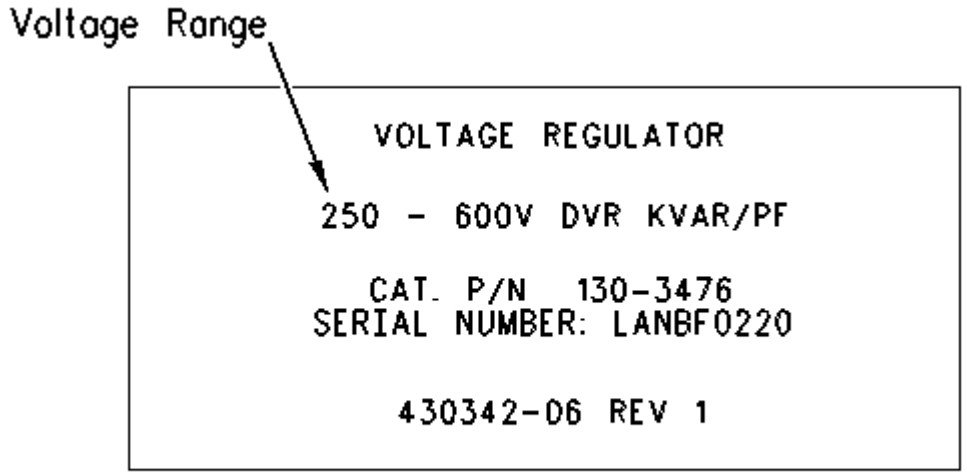

Illustration 1 g00551383
Typical Nameplate On Digital Voltage Regulator

Perform the following measurement as an alternative method in order to find the ratio.

1. Remove wires 26 and 30 from regulator terminals 26 and 30 in order to eliminate the possibility for overvoltage. Remove the wire from B- in order to avoid fault code 803.

2. Start the engine and run at rated speed (high idle).
3. Measure residual generator output voltage.
4. Measure voltage across terminals 20 and 22 of the digital voltage regulator.
5. Shut down the engine.
6. The voltage ratio is equal to the measured generator output voltage divided by the measured voltage that is across terminals 20 and 22.

Note: On an occasion, it may be necessary to flash the field in order to get enough residual voltage for this test.

Parameter :03 - Generator Type Parameter :03 relates to the type of generator which the digital voltage regulator is controlling. This is required for the digital voltage regulator to properly measure the output frequency of the generator. The digital voltage regulator measures frequency by using two of the PM power inputs (26 and 30). The generator frame size is indicated on the nameplate which is located on the outside of the generator terminal box.

NOTICE

Additional components (potential transformers) are required when the digital voltage regulator is set for SE operation. If the SE generator and the digital voltage regulator are not connected properly, the digital voltage regulator can be permanently damaged.

In a self-excited (SE) application, the PM power inputs to the digital voltage regulator must be connected to power transformers. Two power transformers are required to be connected in an ungrounded open delta configuration. Each transformer must be capable of supplying 1200 VA. The PM inputs must not exceed 120 VAC line to line. For example, if the generator has a 480 VAC output, use 4:1 transformers. The transformers must be fused on the primary side.

Table 2

Parameter Code :03 - Generator Type				
Parameter Value	**Exciter Type**	**Frame Size**	**Gen Poles**	**Engine Speed**
0	SE	All	All	All
1	PM	440	6	1000/1200
2	PM	440	4	1500/1800
3	PM	580-820	6	1000/1200

4	PM	580-820	4	1500/1800

Parameter :04 - **Rated Generator Output Current** The parameter is set to the rated output current that is on the nameplate of the generator and is set at a 0.8 power factor. The rated generator output current is the 100% maximum rating that includes the real current and the reactive current. The digital voltage regulator does not use this parameter to limit current. However, the parameter must be set properly for the paralleling and line loss compensation functions in order to operate correctly. The rated generator output current is indicated on the nameplate. The nameplate is located on the outside of the generator terminal box.

Parameter :05 - **CT Voltage At Rated Generator Current** The voltage that the digital voltage regulator will have at the droop current transformer (CT) input at rated generator current. This entry is used for droop, line loss compensation, KVAR/PF control, and calculation of the monitoring parameters :52, :53, :54, :56, :57, and :58. The parameter must be set properly for the monitoring, paralleling, and line loss compensation functions in order to operate correctly. The value can be calculated by using the following formula.

$V_{ct}=(I \times W \times R \times N) / (T \times O \times C)$

V_{ct} - CT Voltage At Rated Generator Current

I - rated generator output current per phase (value entered for parameter :04)

W - the number of times each generator wire goes through the droop CT window

R - ohms of CT load resistor

N - number of wires going through the droop CT

T - CT turns ratio or (I_{CT} primary) / (I_{CT} secondary)

O - total number of generator output wires per phase, of which some or all may go through the droop CT.

C - generator output voltage connection: 1 for high, 2 for low. Four or six lead generators can only be 1 (high). Ten or twelve lead generators connected in series are also 1 (high). Ten or twelve lead generators connected in parallel are considered 2 (low voltage). A twelve lead generator that is connected in a delta configuration is considered 2 (low voltage). Six lead generators that are connected in a delta configuration are still considered 1 (high).

Another method in order to determine the value for parameter :05 is listed below.

1. Start and run the generator set at full load (available loading).

2. Select parameter :52 and monitor parameter :52 (generator output current).

3. If the value monitored on parameter :52 is not approximately equal (± 5%) to the actual current on phase "B", then adjust parameter :05 up or down until the current monitored is equal to the actual

current.

Note: Increasing parameter :05 will lower the value of parameter :52. Decreasing parameter :05 will increase the value of parameter :52.

Parameter :06 - **Knee Frequency** For a visual description, refer to System Operation, "Startup Profile Function". Also, refer to System Operation, "Loading And Stopping Profile". Parameter :06 is set in hertz (Hz). For better stability, it is recommended that the knee frequency setting be 0.2 to 1.0 Hz below the operating frequency. For voltage sensitive applications, it may be preferable to set the knee frequency value still lower.

Parameter :07 - **Decreasing V/Hz Slope 1.** For a visual description, refer to System Operation, "Loading And Stopping Profile". This parameter is set in percent of voltage change per percent of frequency change.

Parameter :08 - **Decreasing V/Hz Slope 2.** For a visual description, refer to System Operation, "Loading and Stopping Profile". This parameter is set in percent of voltage change per percent of frequency change.

Parameter :09 - **Minimum Voltage** For a visual description, refer to System Operation, "Loading And Stopping Profile". This parameter is set in volts as a percentage of rated voltage (% of parameter :01).

Note: The undervoltage trip point and undervoltage trip time prevent the engine or the generator from operating in an undervoltage condition for an extended time. The minimum voltage (parameter :09) is the lowest operating voltage that the engine or the generator will be able to recover from due to a large load application. Setting the minimum voltage above the undervoltage trip point (parameter :13) eliminates most of the undervoltage protection.

Parameter :10 - **Underfrequency Point** For a visual description, refer to System Operation, "Startup Profile Function". Refer to the System Operation, "Loading And Stopping Profile" section. This parameter is set in hertz (Hz).

Parameter :11 - **Overvoltage Trip Point.** If the voltage is more than this value for a period of time greater than the overvoltage trip time, then an overvoltage shutdown fault will occur. This point is set in percent of generator output voltage (parameter :01). Refer to parameter :12. This feature is intended to operate similar to an ANSI 59 protection relay.

Parameter :12 - **Overvoltage Trip Time.**The time, in seconds, require that the output voltage must be greater than the overvoltage trip point before tripping an overvoltage shutdown fault. Refer to parameter :11.

Parameter :13 - **Undervoltage Trip Point.** If the voltage is less than this value for a period of time greater than the undervoltage trip time, then an undervoltage shutdown fault will occur. This point is set in % of generator output voltage (parameter :01). Refer to parameter :14. This protection is not enabled when the optional excitation disable switch is closed or when the running profile or the operating profile is not used. This feature is intended to operate similar to an ANSI 27 protective relay.

Parameter :14 - **Undervoltage Trip Time.** The time, in seconds, require that the output voltage must be lower than the undervoltage trip point before tripping an undervoltage shutdown fault. Refer to parameter :13.

Note: The undervoltage trip point and undervoltage trip time prevent the engine or the generator from operating in an undervoltage condition for an extended time. The minimum voltage (parameter :09) is the lowest operating voltage that the engine or the generator will be able to recover from due to a large load application. Setting the minimum voltage above the undervoltage trip point (parameter :13) eliminates most of the undervoltage protection.

Parameter :15 - Voltage Gain (Line Loss Compensation) This parameter increases the voltage reference in order to compensate for voltage drops in the wires (resistance) from the generator to the load. This drop is dependent on the amount of current flowing through the wires. The value is entered in a percentage of generator output voltage (parameter :01). Reactive droop (parameter :30) may have an effect on the voltage reference in the opposite direction. Either voltage gain or voltage droop may be used. However, both of the parameters should not be used simultaneously. One or both of these parameters should always be zero. Refer to System Operation, "Voltage Regulation". Refer to the System Operation, "Line Loss Compensation" section. This feature requires the presence of a droop current transformer.

Parameter :16 - Integral Gain This parameter changes the transient performance of the digital voltage regulator if the DVR is in voltage control mode. The integral gain parameter is preset at the factory for the generator. The integral gain parameter must not be adjusted unless the resulting effect is fully understood. An incorrect adjustment may cause the output voltage to overshoot or to oscillate. Increasing this value may improve regulation accuracy but can cause it to be more unstable. The shorter the generator time constant the higher this parameter should be set. Hunting may be experienced if the gain is too low. This parameter should generally be set within the range of 1.0 to 9.0.

Parameter :17 - Proportional Gain The proportional gain parameter changes the transient performance of the digital voltage regulator when the digital voltage regulator is in voltage control mode. The proportional gain parameter is preset at the factory for the generator. The integral gain parameter must not be adjusted unless the resulting effect is fully understood. If the proportional gain is increased, the response of the regulator will improve to load changes. However, the increased gain may cause voltage overshoot or voltage instability. This parameter should generally be set within the range of 1.0 to 9.0. This parameter should be close to the value for parameter :16.

Parameter :18 - Single Phase Sensing Select If single phase sensing is required, set this value to 1. The default setting is 0 for three-phase sensing. This is required to regulate the proper voltage. When single phase sensing is selected, all KVAR and PF features are disabled. When single phase sensing is selected, the option to view the monitor functions :56, :57, and :58 is disabled. The regulators that have a part number that begins with 155-xxxx, and if single phase sensing is selected, all of the KVAR, PF, reverse VAR and reverse power features and viewing of monitor functions :56, :57 and :58 are disabled.

Parameter :19 - Diode Monitor Trip Point The diode monitor trip point parameter sets the allowable amount of field current variation (ripple) before the digital voltage regulator can detect a rotating diode that may be faulty. If the value is exceeded for a period of five seconds, a rotating diode shutdown fault will occur. Initially, this value should be set to the no load field current that is monitored on parameter :55. Lower the value (increase sensitivity) in order to lower the allowable current difference. Raise the value (decrease sensitivity) in order to raise the allowable current difference.

Parameter :20 - Reverse VAR Trip Time This parameter represents the time, in seconds, required in order to trip the reverse VAR faults. The fault codes are code 604 and code 704. This protective fault is defined as "0.4 Per Unit" or greater leading KVARs. Entering a longer time will allow time to compensate for added loads. The settle time for the system will depend on the size of the added load. Refer to parameter :21. This parameter was added for regulators with the part number 155-xxxx and

newer. This feature is intended to operate similar to an ANSI 40 protective relay.

Parameter :21 - Reverse VAR Fault Selection This parameter configures the response of the digital voltage regulator when the DVR is exposed to a reverse VAR condition. This fault may be configured to be disabled (no fault), to be a shutdown fault or an alarm fault. When parameter :21 is set to 0 (zero), detection of the reverse VAR fault is disabled. This disables fault code 604 and fault code 704. When parameter :21 is set to 1, the fault is treated as an alarm fault. If parameter :21 is set to 1, then fault code 604 will be enabled and fault code 704 will be disabled. If parameter :21 is set to 2, the fault is treated as a shutdown fault. If parameter :21 is set to 2, then fault code 704 will be enabled and fault code 604 will be disabled. Refer to fault code 604 and fault code 704. This parameter was added for regulators with the part number 155-xxxx and newer.

Parameter :22 - Droop/CCC Select This parameter is used to select between voltage regulation, voltage droop and cross current compensation (CCC) modes when operating in voltage control mode. When CCC mode is selected, parameters :52, :53, :54, :56, :57, and :58 are disabled as well as the reverse power fault code 705 and reverse VAR fault codes 604 and 704. This parameter has no effect on the KVAR or PF modes of operation. This parameter is ignored when terminal 41 is closed to terminal 50 that enables the optional KVAR or PF regulation mode. This parameter was added for regulators with the part number 155-xxxx and newer.

Parameter :30 - Droop Percentage Refer to System Operation, "Reactive Voltage Droop Function". Refer to System Operation, "Cross Current Compensation". This parameter defines generator output voltage droop, in percent, at the rated generator reactive current. This parameter is effective only when in voltage droop mode. Refer to parameter :22). The rated current for the generator is defined by parameter :04 and parameter :05. Either voltage gain or voltage droop may be used, but both parameters must not be used simultaneously. One or both of these parameters should always be zero. This parameter has no effect on the KVAR or PF modes of operation. This parameter is ignored when terminal 41 is closed to terminal 50 that enables the optional KVAR or PF regulation mode. This feature requires the use of a droop current transformer. Service personnel must remember that a leading reactive current will cause the voltage to rise rather than to droop.

Parameters :31 through :38 apply only to the digital voltage regulators with the optional KVAR, PF and reverse power functions. All the features require the presence of a droop current transformer. Several notes for this option are listed below.

- The KVAR and PF option is not operable if the 52/a contacts are not closed, that is, if terminal 41 is open to terminal 50. Parameters :4 and :5 must be configured correctly for proper operation in the KVAR and PF mode.
- The reverse power function is not active unless the KVAR and PF mode is enabled or the droop mode is selected in parameter :22.
- If the droop current transformer (CT) is connected in a cross current compensation (zero droop) configuration and 52/a contacts are closed (thus enabling the KVAR/PF controller), the regulator will not operate properly. The regulator will trip. Various faults will be indicated. A common fault will be the reverse VAR fault. Properly installed contactors may be used in order to allow the setup of both configurations so that either one can be used at any given time.
- If the KVAR and PF mode is enabled when the generator is connected to an isolated load (not connected to a utility), then an unstable operating condition exists because it is not possible to

simultaneously regulate voltage and power factor (or KVAR).

- If single phase sensing, parameter :18, is selected, monitoring functions :56, :57, :58 and all PF and KVAR optional features will be disabled.

Parameter :31 - PF/KVAR Select (optional feature). This parameter selects whether the power factor (PF) or the KVARs will be regulated when the power factor and KVAR mode is activated. This mode is activated by applying 24 volts DC to the VAR/PF enable input. The VAR/PF enable input must be wired to terminal 41 of the regulator. **Always use terminal 50 for the 24 volt DC source.** Set parameter :31 to 0 for PF control. Set parameter :31 to 1 for KVAR control. The default for parameter :31 is 0.

Parameter :32 - PF Reference (optional feature). When PF control is active, the value that is entered for this parameter is used as the reference for regulation. Power factor is the ratio of real power (kW) divided by apparent power (kVA) of the generator. The value range of this parameter is adjustable from 0.6 (lagging) to 1.1. The value 1.1, represents a leading power factor of 0.9. If a remote adjustment rheostat is used in order to manually adjust the power factor, the setting for parameter :32 will not be modified. The setting for parameter :32 will be ignored. Refer to System Operation, "Customer Options". The PF/KVAR switch that is at terminal 41 must be enabled. The "real output" of the generator must be above the level that is defined by parameter :38 in order for this feature to operate. Refer to System Operation, "Power Factor Regulation" for more details and for the history of changes to this feature.

Parameter :33 - KVAR Reference (optional feature). If KVAR control is active, the value that is entered for this parameter will be used as the reference for KVAR regulation. The value is entered as "per unit KVARs". The adjustment range is from 0.0 to 1.0. The PF and KVAR mode switch that is accessed at terminal 41 of the regulator, must be enabled in order for this feature to operate.

The digital voltage regulator defines "1 Per Unit KVARs" as 100% of the rated KVARs. The rated KVARs is equal to 0.6 of the rated generator kVA. This fixed definition is based on the fact that most generators are rated for the kW capacity at 0.8 power factor, which defines the ratio to overall kVA capacity. Parameters :01 and :04 define rated generator kVA. By definition, $KVA^2 = KW^2 + KVAR^2$. Therefore, at full rated conditions and with a power factor of 0.8, and KW/KVA = 0.8, the KVARs will be 0.6 times the rated kVA.

If a remote adjustment rheostat is connected to regulator terminals 44 and 45, and parameter :31 is set to 1, which selects KVAR regulation, the rheostat will have a full range of adjustment for the KVAR reference. The range of adjustment will be 0.0 to 1.0 per unit. The KVAR reference value, that is stored in parameter :33, will not be modified. The KVAR reference value will be ignored.

On regulators with part number 155-xxxx and newer this value is used in power factor mode as well. When in PF control mode (parameter :31 is set to zero), the value entered in parameter :33 will be used as the KVAR reference when the generator real current level is below that defined by the PF switch point (parameter :38). Refer to System Operation, "KVAR Regulation" for more detail. See also System Operation, "Power Factor Regulation".

Parameter :34 - Reverse Power Trip Point. If the generator is subjected to a reverse power level greater than this value for a period of time greater than the reverse power trip time, a reverse power shutdown fault will occur. This value is set in percent of rated real power (KW). See also parameter :35. This feature requires the PF/KVAR mode switch at regulator terminal 41 to be enabled or the droop /

CCC mode (parameter :22) to be set as droop (0) on units with that parameter available. This feature is intended to operate like an ANSI 32 protective relay.

Parameter :35 - Reverse Power Trip Time. The time, in seconds, required that the generator be subjected to a reverse power level greater than the reverse power trip point before tripping a reverse power fault (fault code 705). See also parameter :34.

Parameter :36 - Paralleling Integral Gain (optional feature). This parameter changes the transient performance of the digital voltage regulator only when in KVAR or power factor mode. This is preset at the factory for the generator and should not be adjusted unless the resulting effect is fully understood. Increasing this parameter will improve the regulation accuracy but possibly more unstable. It should be set similarly to parameter :37. This parameter was added on regulator part numbers 155-xxxx and newer.

Parameter :37 - Paralleling Proportional Gain (optional feature). This parameter changes the transient performance of the digital voltage regulator only when in KVAR or power factor mode. This is preset at the factory for the generator and should not be adjusted unless the resulting effect is fully understood. Increasing this parameter will make the generator more responsive to reactive load changes but possibly more unstable. This parameter should be set similarly to parameter :36. This parameter was added on regulator part numbers 155-xxxx and newer.

Parameter :38 - PF Switch Point (optional feature). Power factor cannot be calculated or regulated at low power levels, so the regulator must have a default control until an appropriate level is reached. This parameter is the amount of real current, as a percent of rated generator current, that is needed before power factor (PF) mode becomes active when PF mode is selected. Until the real current reaches this point, the unit will run in KVAR mode using parameter :33 for a reference. After the generator has switched to power factor control, if the real current falls 5% below the value set for this parameter, the digital voltage regulator will switch from the power factor control back into KVAR control. This 5% hysteresis is built in to prevent ringing, or unstable operation. Parameter :33 must be set to an appropriate level to ensure a smooth transition to PF mode. The rated generator current is as defined in parameters :04 and :05. This parameter was added on regulator part numbers 155-xxxx and newer.

Parameter :50 - Generator Output Frequency (view only). This parameter is the output frequency of the generator as calculated by the digital voltage regulator. It is based on the measured frequency of AC power input to the digital voltage regulator (PMG terminals 26 and 30), and the generator type (parameter :03), SE or PM.

Parameter :51 - Generator Output Voltage (view only). This parameter is the true RMS output voltage as measured by the voltage input of the digital voltage regulator (after the sensing voltage transformers if present). The value is the average of all three sensing voltage inputs unless single phase sensing is selected. The value is based on parameters :01 and :02.

Parameter :52 - Generator Output Current (view only - total current). This parameter is the measured generator output current in amps of the "B" phase. The accuracy depends upon proper adjustments to parameter :04 and parameter :05. For units with parameter :22, this monitor will read zero if the digital voltage regulator is operated in cross current compensation mode (parameter :22 is set to 1). For older models, this monitor will not be correct if the digital voltage regulator is connected in cross current compensation mode. This feature requires the presence of a droop current transformer. See parameters :04, :05, and :22.

Parameter :53 - Generator Reactive Output Current (view only). This parameter is the digital voltage regulator calculated reactive portion of the generator "B" phase output current. It is the reactive portion of the current represented in parameter :52. For units with parameter :22, this monitor will read zero if the digital voltage regulator is operated in cross current compensation mode. For older models, this monitor will not be correct if the digital voltage regulator is connected in cross current compensation mode. This feature requires the presence of a droop current transformer. See parameters :04, :05, and :22.

Parameter :54 - Generator Real Output Current (view only). This parameter is the calculated real portion of the generator output current. It is the real portion of the current represented in parameter :52. For units with parameter :22, this monitor will read zero if the digital voltage regulator is operated in cross current compensation mode. For older models, this monitor will not be correct if the digital voltage regulator is connected in cross current compensation mode. This feature requires the presence of a droop current transformer. See parameters :04, :05, and :22.

Parameter :55 - Exciter Field Current (view only). This parameter is the measured exciter field current (in amps) at the output of the digital voltage regulator.

Parameter :56 - Kilowatts (view only). This parameter is the digital voltage regulator calculated measurement of the generator output in kilowatts. This function is only available on the PF/KVAR optional version and when 3 phase sensing is selected. The accuracy depends upon proper adjustments to parameter :04 and parameter :05. For units with parameter :22, this monitor will read zero if the digital voltage regulator is operated in cross current compensation mode. For older models, this monitor will only operate when the KVAR/PF control mode is enabled. This feature requires the presence of a droop current transformer. Monitoring parameter :56 was previously providing only single phase (phase "B") information for KW. Effective with serial number prefix "KE" and later, digital voltage regulator parameters :56 and :58 now provide three phase information on KW and KVAR. However, there is only one current transformer (CT) and the three phase information is based on a balanced three phase load. If the load is unbalanced, the error will be proportional to the unbalance. See also parameters :04, :05, and :22.

Parameter :57 - Power Factor (view only). The value of this parameter is the digital voltage regulator calculated ratio of real power (KW) divided by apparent power (KVA), or the cosine of the angle between those two. This function is only available on the KVAR/PF optional version and when 3 phase sensing is selected. The accuracy depends upon phase load balance and proper adjustments to parameter :04 and parameter :05. For units with parameter :22, this monitor will read zero if the digital voltage regulator is operated in cross current compensation mode. For older models, this monitor will only operate when the KVAR/PF control mode is enabled. This feature requires the presence of a droop current transformer. See also parameters :04, :05, and :22.

Parameter :58 - KiloVARs (view only). This function is only available on the PF/KVAR optional version when 3 phase sensing is selected. This parameter is the digital voltage regulator calculated measurement of the generator output in KVARs. There is only one current transformer (CT) and three phase information is based on a balanced three phase load. If the load is unbalanced, the error will be proportional to the unbalance. This parameter has been added effective with serial number prefix "KE" and later units. The accuracy depends upon phase load balance and proper adjustments to parameter :04 and parameter :05. For units with parameter :22, this monitor will read zero if the digital voltage regulator is operated in cross current compensation mode. For older models, this monitor will only operate when the KVAR/PF control mode is enabled. This feature requires the presence of a droop current transformer. See also parameters :04, :05, and :22.

Parameter :60 - Hours (view only). This parameter is the number of hours that a measurable frequency has been applied to the AC power input of the digital voltage regulator. This will typically occur when the generator is operated above 15% normal rpm. Time is accumulated in 0.25 hours and shown in full hours only.

Parameter :70 - Voltage Adjust (optional feature). This parameter is available only through the serial communications port. It is designed to allow a remote control device (PLC) to modify the regulated voltage level reference by up to ±10% from the value set in parameter :01. The minimum value, 0 (zero), will decrease the regulated voltage level by 10%. The maximum value of 200 will increase the voltage level by 10%. A value of 100 will leave the voltage level reference unchanged. The value of parameter :01 does not change. The internal voltage reference value changes. The value of parameter :70 is stored in computer memory but not in non-volatile memory. This feature allows the remote control device to repeatedly send a new reference voltage value to parameter :70 without risk of wearing out the non-volatile memory storage device. The value of parameter :70 will default to 100 (zero offset) on each re-application of +24 VDC power to "B+" and "B-". It will also reset to 100 (no offset) upon generator shutdown (defined as zero frequency). When the generator is restarted, it will remain at 100 (no offset) until modified from the serial communications link. Refer to System Operation, "Remote Communications". This parameter was added on regulator part numbers 155-xxxx and newer.

If a remote voltage adjust rheostat is present, it will work in conjunction with the value of parameter :70. The position of the remote voltage adjust rheostat is internally converted to a percentage offset similar to that described above. The percentage offset from the rheostat is added to the percentage offset from parameter :70 to create a combined offset. The net result will be limited to a maximum total deviation of ±10% from the setting of parameter :01.

Parameter :71 - PF/KVAR Adjust (optional feature). This parameter is available only through the serial communications port. It is designed to allow a remote control device (PLC) to provide the regulation reference for control of power factor (PF) or KVARs when that operating mode is active. The reference value (PF or KVAR) to be modified is determined by parameter :31. The actual reference to be modified can be from either parameter :32 (PF) or :33 (KVARs), or from the remote PF/KVAR adjust rheostat, if provided. Note, however, when parameter :31 is configured for PF operation and the PF switch point (parameter :38) has not been reached, no remote adjustment of the KVAR level is possible. Remote adjustment is only possible when the PF switch point (parameter :38) has been reached. See the description of KVAR/PF operation for further clarification. This parameter was added on regulator part numbers 155-xxxx and newer.

The numeric value range of parameter :71 is 0 - 200. It will act as a ± offset to the value of the selected reference as calculated in the following manner.

- In the KVAR mode (parameter :31 set to 1), the offset is calculated as:

KVAR Offset = (Parameter :71)/100 - 1.

This offset is combined with the existing KVAR reference using signed addition, then limited so that the resulting effective reference will be between 0 (zero) and 1.0 (maximum rated KVARs). Refer to the explanation of parameter :33. A numeric value of parameter :71 larger than 100 will therefore cause an increase in lagging KVARs. A value less than 100 will reduce lagging KVARs. A value of 100 will cause no offset change. The range of parameter :71 is such that the serial communications control device can adjust the KVARs over the entire operating range, regardless of the setting of parameter :33 or the remote PF/KVAR adjust rheostat (if one is present).

- In the PF mode (Parameter :31 set to zero), the offset is calculated as:

PF Offset = 0.4 x (1 - (Parameter :71)/100)

This offset is combined with the existing PF reference using signed addition, then limited so that the resulting effective reference will be between 0.6 (minimum lagging PF) and 1.1 (maximum PF, 0.9 leading). Refer to the explanation of parameter :32. A numeric value of parameter :71 less than 100 will therefore increase the PF, making it less lagging (more leading). A value greater than 100 will reduce it (more lagging). A value of 100 will cause no offset change. The range of parameter :71 is such that the serial communications control device can adjust the PF over the entire operating range only if parameter :32 or the remote PF/KVAR adjust rheostat (if one is present) is set for a PF of or between 0.7 and 1.0. Adjustment of PF is still possible when parameter :32 is set outside 0.7 to 1.0 but the full range is not available.

The value of parameter :71 is stored in computer memory but not in non-volatile memory. This allows the remote control device to repeatedly send a new reference PF/KVAR value to parameter :71 without risk of wearing out the non-volatile memory storage device. Parameter :71 will default to 100 (zero offset) on each re-application of +24 VDC power to "B+" and "B-". It will also reset to 100 (no offset) upon generator shutdown (defined as zero frequency). When the generator is restarted, it will remain at 100 (no offset) until modified from the serial communications link.

If the generator installation is intended to be monitored and controlled by a programmable logic controller (PLC) using serial communications to parameter :71, it is recommended that parameter :32 (PF) or :33 (KVAR) (whichever is intended to be remotely controlled) be consistently set to 1.0 PF or 0.0 KVARs, and that a manual PF/KVAR remote adjust rheostat not be connected. If a manual remote adjustment rheostat is required, it should be disconnected with a control relay when the PLC serial communications control is active so that the known numeric value stored in parameter :32 or :33 is used for the offset calculation. The remote PLC will then have a consistent numeric means to control the PF or KVARs regardless of the position of the rheostat. The exact expressions that the PLC would need to calculate are listed below.

- Parameter :71 $_{KVAR}$ = 100 x (1 + Desired_PU_KVARs - Parameter :33)

- Parameter :71 $_{PF}$ = 100 x (1- (Desired_PF - Parameter :32) / 0.4)

If the above recommendations are followed (Parameter :33 = 0.0, Parameter :32 = 1.0, no remote rheostat), values between 100 to 200 will set KVARs from 0 to 1.0 per unit and values between 200 to 75 will set the effective PF reference from 0.6 to 1.1.

Parameter :90 - Password. The Password function operates as a lockout to help prevent accidental modification of other parameter settings. When parameter :90 is set to "0009", no other parameters can be modified from the keypad or serial communication link (including parameters :70 and :71). When parameter :90 is set to any other value, all configurable parameters may be modified from either the keypad or serial communications link.

Parameter :91 - Software ID (PROM ID) (view only). Software ID (PROM ID) (view only). This parameter is the number or version of the software within the digital voltage regulator, used for a factory guided reference.

Parameter :92 - Latest Fault. This parameter contains the fault code of the most recently declared, or

current, fault that has occurred after the last fault was reset. It may contain either alarm or shutdown faults. If a shutdown fault is active (has not been reset) and an additional fault occurs, the additional fault will be ignored. However, if an alarm is active (has not been reset) and an additional shutdown fault occurs, the alarm code will be moved into the Previous Fault location (parameter :93) and the new shutdown fault will be stored in the Latest Fault location (parameter :92). When no active fault is present (any previous fault has been reset) and parameter :94 is activated, the value of parameter :92 is moved to :93 while leaving zero in :92. The fault code is retained during power-down and power-up of the digital voltage regulator. For earlier digital voltage regulators, refer to System Operation, "Parameters", the topic Parameter Exceptions.

Parameter :93 - Previous Fault. This parameter contains the fault code for the previous fault (both alarm and shutdown faults) that was stored in parameter :92. There is an exception. This parameter may contain an active alarm if an active alarm was present in parameter :92 and a shutdown fault occurred. When the parameter :92 is cleared using the fault clear function (parameter :94), or a new fault is declared, the fault code stored in parameter :92 is moved to this location (parameter :93), and any previous fault code stored in this location will be lost. The fault code is retained during power-down and power-up of the digital voltage regulator. For earlier digital voltage regulators, refer to System Operation, "Parameters", the topic Parameter Exceptions.

Parameter :94 - Fault Clear. This parameter acts like a switch to clear fault codes from the latest fault (parameter :92) and the previous fault (parameter :93) locations. In order to activate this function, select parameter :94 on the display and press the function key. Each time the fault clear function is used, the display will flash three times, the fault code stored in parameter :92 is moved to parameter :93, and the display returns to parameter :01. If there is a fault code in the previous fault location (parameter :93), it will be lost since the value from the latest shutdown fault will now occupy that location. The fault codes stored in parameters :92 and :93 cannot be cleared until the active fault has been reset. For earlier digital voltage regulators, refer to System Operation, "Parameters", the topic Parameter Exceptions.

Parameter :95 - Alarm Fault. Parameter :95 is not used. For earlier digital voltage regulators, refer to System Operation, "Parameters", the topic Parameter Exceptions.

Parameter :96 - Shutdown Fault Reset. This parameter acts like a switch to reset an active fault. Resetting an active fault will allow the digital voltage regulator to begin regulation again and stop the display from flashing the fault code. In order to activate this function, select parameter :96 on the display and press the function key. The display will flash three more times and then return parameter :01. Note, that if there is no active fault, the display will flash three times and remain at parameter :96. This parameter applies to all alarm and resettable shutdown faults, fault codes 6xx and 7xx. In order to reset non-resettable shutdown faults (800 level), power-down the digital voltage regulator (remove 24 VDC from "B+/B-" inputs). Resetting an active fault does not affect the contents of parameters :92 and :93. Active resettable shutdown faults may also be reset using the Fault Reset input terminal, refer to System Operation, "Customer Options". For earlier digital voltage regulators, see System Operation, "Parameters", the topic Parameter Exceptions.

NOTICE

When a shutdown fault code is reset, the digital voltage regulator will begin operation again. If the generator is being driven, it will begin to regulate according to engine /generator speed and the regulation mode selected.

Parameter Exceptions For Earlier Digital Voltage Regulators

The chart lists the serial number break between the earlier and the current fault parameters. All digital voltage regulator part numbers starting with 116 (116-xxxx) and some of the regulator part numbers starting with 130 (130-xxxx) use the earlier fault parameters. The current fault parameters will be implemented on all versions of the digital voltage regulator built after March 1996. Another method to determine if a digital voltage regulator uses the current fault parameters is to check the PROM ID (parameter :91). A value of 1.03 or greater indicates use of the current alarm/fault parameters.

Note: Alarm and fault troubleshooting is discussed in Testing And Adjusting, "Fault Handling For Earlier Digital Voltage Regulators".

Table 3

Earlier Fault Parameter Serial Number Break	
Digital Voltage Regulator Part Number	**Earlier Fault Parameter Serial Number**
130-3471	LBNBA1-0123
130-3472	LBNBB1-0301
130-3473	LBNBC1-0176
130-3474	LBNBD1-0190
130-3475	LBNBE1-0392
130-3476	LBNBF1-0238

Parameter :92 - Latest Fault. This parameter contains the fault code of the shutdown fault that first occurred since this parameter was reset. If any additional shutdown faults occur, they are not recorded until the existing fault is reset. The fault code is retained during power-down and power-up of the digital voltage regulator. When a shutdown fault occurs, the corresponding fault code is automatically flashed on the display. Any information shown on the display flashes until the shutdown fault reset parameter :96 is activated. When no fault is present and parameter :92 is cleared, the value of parameter :92 is zero.

Parameter :93 - Previous Fault. This parameter contains the fault code for the last shutdown fault that was reset and cleared. When an active shutdown fault (parameter :92) is reset and cleared, the fault code is moved to this location (parameter :93). The fault code is retained during power-down and power-up of the digital voltage regulator. An active shutdown fault is reset using the fault reset switch or the parameter :96. It is cleared and moved into parameter :93 using the fault clear parameter :94.

Parameter :94 - Fault Clear. This parameter acts like a switch to clear fault codes from the latest fault parameter :92 and the alarm fault parameter :95. Each time the fault clear function is used, the alarm fault parameter :95 is cleared to zero and the value in the latest fault parameter :92 is moved to the previous fault parameter :93. If there is a fault code in the previous fault parameter :93, it will be lost

since the value from the latest fault will now occupy that location. Clearing a fault code also stops the display from flashing. Clearing DOES NOT RESET shutdown faults. Before clearing an alarm/fault, check parameters :92 and :95 to see if an active fault is present, as this may aid in troubleshooting. To clear a fault code, select parameter :94 on the display and press the function key.

Parameter :95 - Alarm Fault. This parameter contains the fault code of the first alarm fault that occurred since this parameter was cleared. If any additional alarm faults occur, they are not recorded until the existing alarm fault is cleared. The code is retained during power-down and power-up of the digital voltage regulator. When an alarm fault occurs, the corresponding fault code is automatically flashed on the display. The alarm code information shown on the display flashes until the fault clear parameter :94 is activated. When no alarm fault is present, parameter :95 is zero. The regulator will continue to operate when an active alarm fault exists.

Parameter :96 - Shutdown Fault Reset. This parameter acts like a switch to reset a shutdown fault so that the digital voltage regulator can begin operation again. This parameter only applies to resettable shutdown faults. In order to reset non-resettable shutdown faults, power-down the digital voltage regulator by removing 24 VDC from "B+/B-" inputs. When a shutdown fault code is reset, the digital voltage regulator is able to begin operation again. Resetting a fault code also stops the display from flashing. Resetting does nothing to the latest fault parameter :92) or the alarm fault parameter :95). In order to reset a resettable shutdown fault code, select parameter :96 on the display and press the function key. Parameter :96 performs the same function as the external fault reset switch. See the Customer Options diagram in Testing And Adjusting, "Wiring Diagrams".

Sat Aug 27 10:59:25 EDT 2011