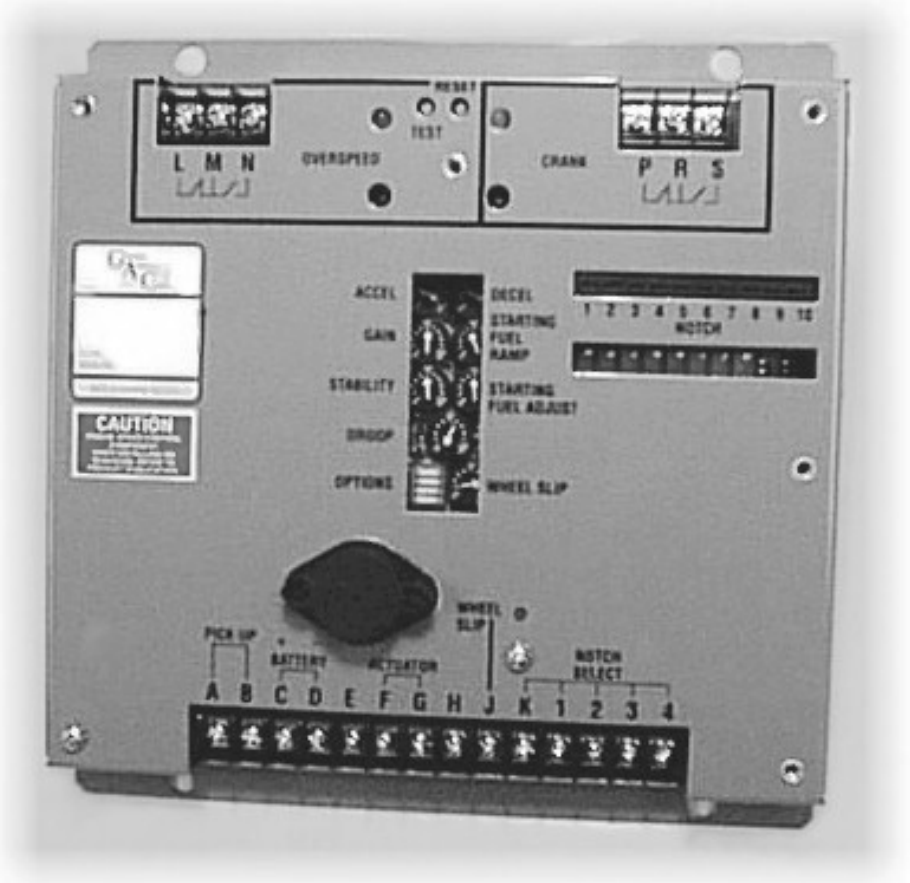
GOVERNORS AMERICA CORP.

ENGINE GOVERNING SYSTEMS

LCC210A
LOCOMOTIVE SPEED CONTROL



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LCC210A
LOCOMOTIVE SPEED CONTROL

PRODUCT INFORMATION BULLETIN

PIB1113

Rev. A

INTRODUCTION

The LCC210A Locomotive Speed Control integrates the functions of several modules into one speed control system for direct drive locomotives not requiring excitation controls or other special applications. The LCC210A is an 8 notch engine speed control that includes speed ramping, wheel slip control, and a two element speed switch.

The engine speed control is a high performance, isochronous or droop, closed loop speed control system similar to GAC's latest ESD Series of speed control units. The speed input is typically from a magnetic pick-up that measures flywheel speed. The output of the LCC210A electrically drives a Cummins EFC actuator, a ADB120E4 from GAC, or one of the other GAC proportional actuators such as the 275 SERIES.

DESCRIPTION

SPEED SELECTION

Operating speed is selected through a four wire coded speed selector system typically used in locomotives. Sixteen distinct speeds are possible. Up to 10 of the 16 positions are available. Each notch position has a separate speed adjustment. Any of the 16 possible wire combinations may be factory selected with internal jumpers on a programming pad.

Each notch speed is adjustable within a limited speed range by an independent potentiometer. An LED bar graph indicates the selected notch.

GOVERNOR PERFORMANCE ADJUSTMENT

Governor performance can be optimized with the PID adjustments. The GAIN (P), STABILITY (I), and DEAD TIME (D) are adjustable with potentiometers or switches. The OPTION switches allow gain reduction and dead time compensation adjustment.

SPEED RAMPING

An internal speed ramping circuit has adjustments to control engine acceleration and deceleration rates. These adjustments are provided to insure smooth speed transitions when the notch position is changed.

CRANK TERMINATION

A crank termination speed switch with relay contacts is also provided to operate the starter motor. The multi-turn adjustment sets the point of cranking motor cut out. The green LED indicates that cranking has been terminated. The crank termination relay automatically resets after a decrease of 300Hz from its setting. The standard specification for the LCC210A is to trip at 400 Hz and reset between 0 - 100 Hz.

OVERSPEED SENSING

The independent overspeed sensing circuit has relay contacts to operate a fuel or air shut off valve. The trip point is adjustable with a multi-turn potentiometer. This relay latches once it has been tripped. In the standard LCC210A specification, it resets at 1400 Hz. TEST and RESET switches are provided. When the TEST switch is pressed, the overspeed set point is lowered by 100%. The red overspeed LED indicates the status of this function.

STARTING FUEL CONTROL

Engine starting fuel is controlled by the proprietary GAC starting strategy. The optimum adjustment will greatly reduce excess exhaust smoke during engine starting. START FUEL ADJUST and START FUEL RAMP time adjustments are provided.

Additional features of the LCC210A are: Wheel Slip, Over Voltage Protection, Reverse Voltage Protection, Actuator Short Circuit Protection, and an internal EMI filter for the battery supply.

INSTALLATION

Refer to the Wiring Diagram for proper connections. It is recommended that the magnetic pick-up cable be shielded to Terminal B as shown. It is also recommended that the actuator cable be shielded with its shield connected to Terminal D.

When mounting the LCC210A, attach it to a vertical surface to prevent any moisture from collecting on the circuit board. If vibration is a concern, mount the unit on soft vibration isolators.

CONTROL FUNCTION DESCRIPTION

GAIN
Clockwise adjustment (100) increases the sensitivity of the governor speed control loop. The range is 30:1. (See OPTION switch for additional gain reduction.)

STABILITY
Clockwise adjustment (100) shortens the response time of the governor control loop. The range is 25:1.

DROOP
Clockwise adjustment (100) will add droop to the speed control system. A full CCW (0) adjustment selects the isochronous mode of operation. Droop is proportional the actuator operating current range.

ACCELERATION
A clockwise (100) adjustment will allow the engine speed to increase at a faster rate. Full CCW (0) is the slowest acceleration, approximately 200 Hz/sec.

DECELERATION
A clockwise (100) adjustment will cause the engine to decelerate more quickly. Full CCW (0) is the slowest deceleration; approximately 200 Hz/sec. Engine inertia and load may limit the maximum closed throttle deceleration rate. Do not exceed this setting or a delay may occur on reacceleration.

SPEED NOTCH ADJUSTMENTS 1 - 8
Each notch position has a standard limited range of adjustment. Custom variations are possible.

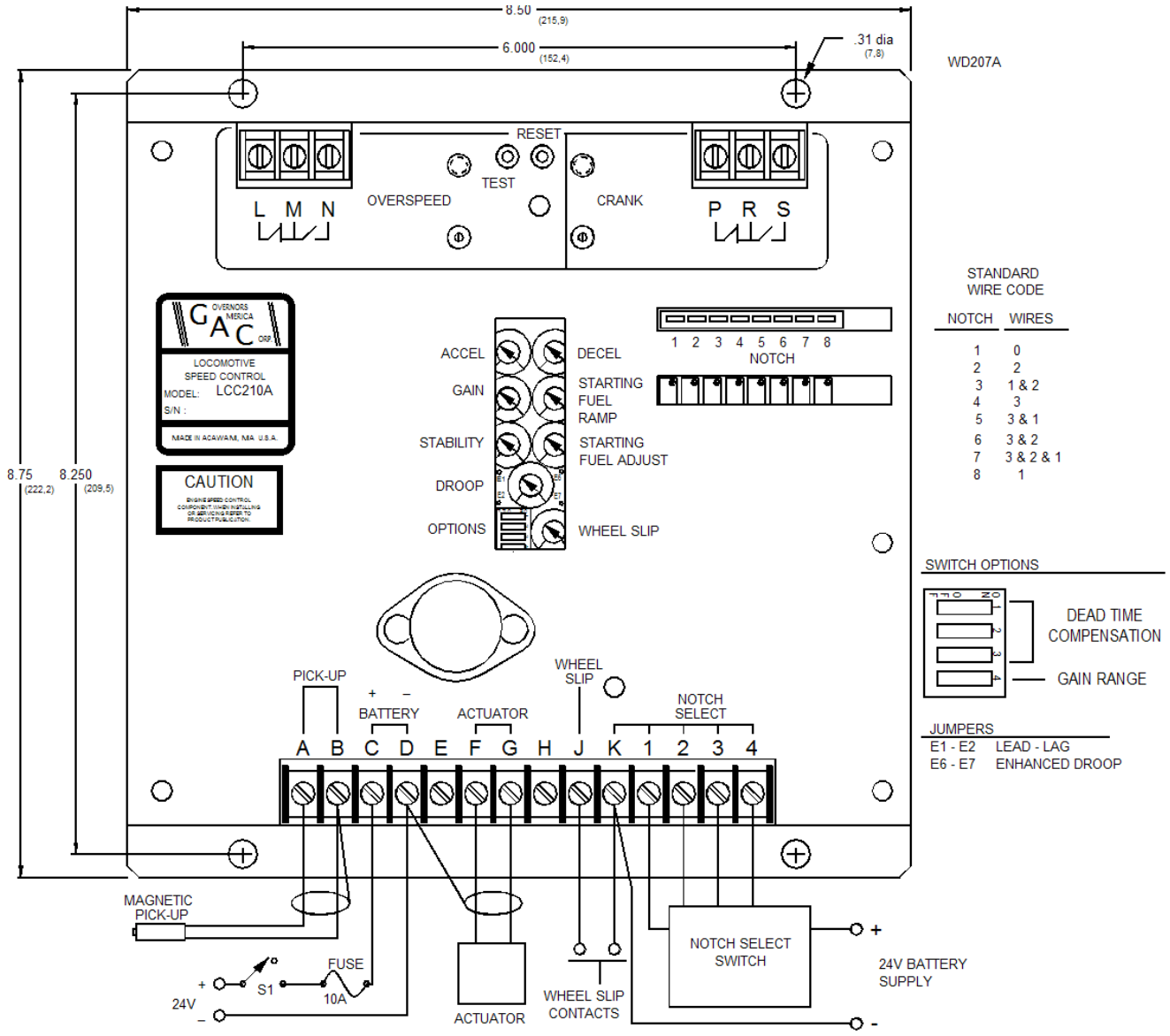
NOTCH	Standard Range of Adjustment (Hz.)
1	1500 – 2000
2	1800 - 3300
3	2000 - 4100
4	2900 - 4900
5	3000 - 5600
6	3000 - 6000
7	3200 - 6400
8	3000 - 5000

Frequency (Hz) = (RPM/60) X Number of gear teeth

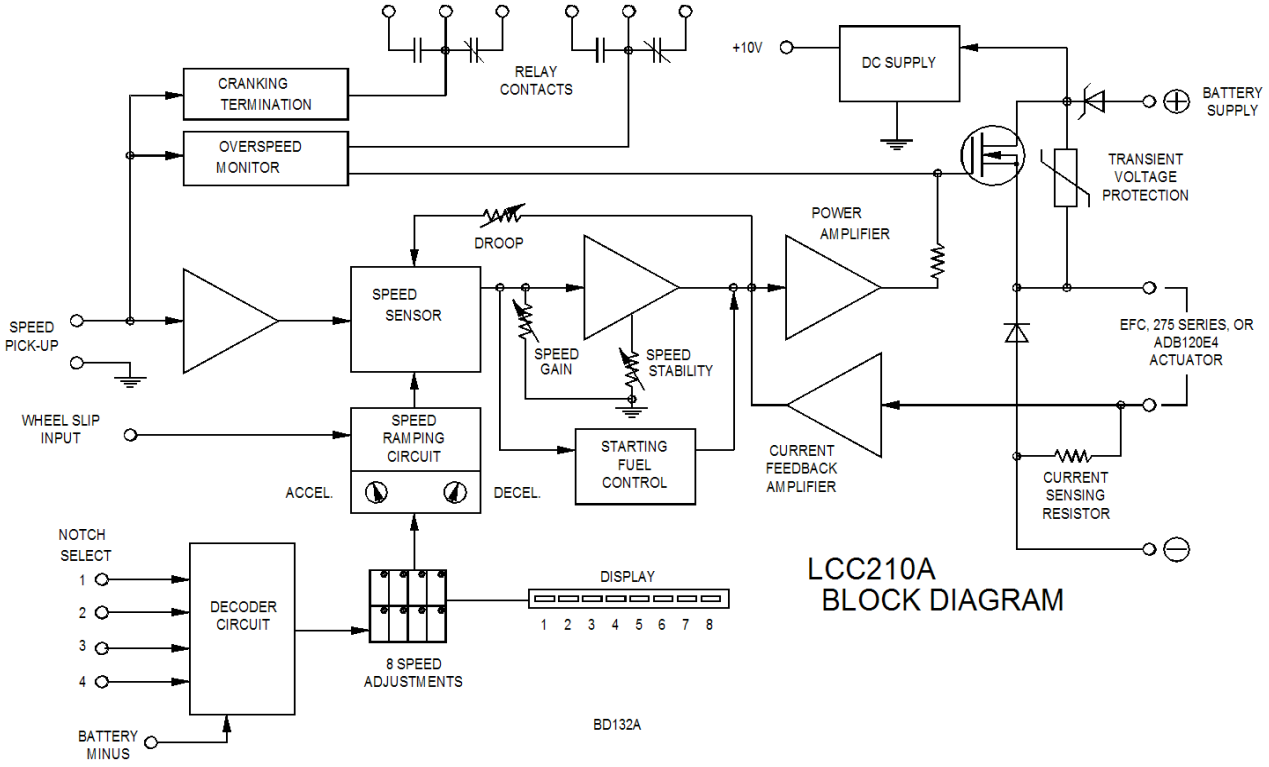
SPECIFICATIONS

DC Input voltage ..... 20 - 32 Volts DC (Nominal 24V DC)
..... Transient and reverse voltage protected to 200V DC
Magnetic pick-up input ..... 0.5 - 50V AC
Actuator Current ..... up to 10 Amps
Speed Droop ..... 0 - 5% based on actuator current change of 2.5 Amps
Acceleration ..... 200 - 1500 Hz/sec 0.8 - 12 sec
Deceleration ..... 200 - 1500 Hz/sec 0.8 - 12 sec
..... may be limited by closed throttle engine deceleration
Speed Switches
Overspeed Range ..... 2000 - 8000 Hz
Crank Termination Range ..... 200 - 1900 Hz
Relay Contact Ratings ..... 10 Amps
Operating Temperature ..... - 40 °C to 80°C
Humidity ..... up to 95%
Vibration ..... per IEC#77
Shock 10g,11msec

WIRING DIAGRAM



BLOCK DIAGRAM



LCC210A
BLOCK DIAGRAM

ADJUSTMENTS

After the LCC210A is properly installed and wired, the system can be adjusted.

The first decision to be made is whether droop is required. If this is not known, then start in the isochronous mode. (DROOP set to 0) A small amount may be added later.

Preset the controls as follows:

GAIN = 50 STABILITY = 50
DROOP = 0 (if requirement is not known)
ACCELERATION = 50
DECELERATION = 80
STARTING FUEL ADJUST = 15
STARTING FUEL RAMP = 50
OPTION SWITCHES
1 = OFF 2 = ON
3 = ON 4 = OFF

1. CRANK TERMINATION SETTING

Select notch 1 and start the engine. As the engine passes approximately 150 RPM, the cranking motor should disconnect. The green LED will illuminate to indicate this action. If the crank termination occurs at too low of a speed, turn the CRANK adjustment CW. If the crank termination occurs at too high a speed, turn the CRANK adjustment CCW.

2. STARTING FUEL ADJUSTMENT

Performing the following adjustments can minimize the engine's exhaust smoke at start up.

Set the STARTING FUEL ADJUST to 15.

Crank the engine and move the STARTING FUEL ADJUST CW until the engine starts. Restart the engine a few times to insure that it starts reliably and the smoke is not excessive.

Adjust the START FUEL RAMP CW to achieve the fastest transition from start up to the Notch 1 speed without producing excessive smoke.

3. Once the engine is running and being governed at the Notch 1 position, make the following adjustments.

Adjust the Notch 1 speed to the desired setting.

Turn the GAIN CW until the engine becomes unstable. Then turn it CCW until stability returns. Turn the GAIN CCW one more division.

Turn the STABILITY CW until the engine becomes unstable. Then turn it CCW until stability returns. Turn the STABILITY CCW one more division.

If the engine is not stable, or the GAIN is set below 20, change OPTION switch 4 to ON. Repeat step 3.0

If the GAIN is still below 20 and/or the system performance is poor, refer to the Instability area of the

TROUBLESHOOTING section for adjustment of the dead time compensation OPTION switches, Lead Lag jumper, and/or the addition of Droop. The system must be stable before continuing on to the next step.

Select the Notch 2 - 8 positions and adjust the SPEED setting of each to the desired speed.

4. Select Notch 1. Quickly switch to Notch 7. Adjust the ACCELERATION for the desired rate of speed increase.

5. From the Notch 7 position, quickly switch to Notch 1. Adjust the DECELERATION for the desired rate of speed decrease. Do not adjust the deceleration for a rate faster than the engine can decelerate. If in doubt, connect a voltmeter across Terminals F and G. When decelerating, the actuator voltage should never go to 0 volts. A minimum voltage of approximately 4 volts is recommended.

6. OVERSPEED SET POINT
When in the Notch 7 position (100% speed), push and hold the overspeed TEST switch. Turn the OVERSPEED adjustment CCW until the overspeed LED illuminates. Release the TEST switch and push the RESET switch. The overspeed condition should clear. Confirm the setting by turning the SPEED setting CW until the overspeed trips again (approximately 110%). Push RESET to clear the overspeed condition and readjust the Notch 7 speed to its correct setting.

7. WHEEL SLIP
If a wheel slip condition occurs, the speed setting should be quickly reduced. Closing a wheel slip sensing contact between Terminals J and K will significantly lower the speed setting of the LCC210A. The WHEEL SLIP adjustment sets the lowest level to which the speed will fall during a wheel slip condition. The rate of speed decrease is determined by the DECELERATION adjustment.

8. Droop may be required by some applications for purposes other than increasing stability. After setting the DROOP (CW increases droop), it is necessary to reset the speed setting of each notch.

The LCC210A should be ready for operation at this point, but it is recommended that all cabling and settings be rechecked.

TROUBLESHOOTING

Rapid Instability

If the instability is rapid (> 3 Hz), remove the Lead - Lag jumper from posts E1 and E2 located to the left of the DROOP adjustment. Readjust the performance of the system per paragraph 2.

If rapid instability is still present, set the OPTION switches in the following order until stability is achieved.

	SWITCH			
	1	2	3	4
Step 1	OFF	ON	ON	ON
Step 2	ON	ON	ON	ON

After each step, readjust the GAIN and STABILITY as described in paragraph 2.0.

If rapid instability still exists, add a jumper wire between posts E6 and E7 located to the right of the DROOP adjustment. Readjust the system per paragraph 2. and the OPTION switch table above.

Slow Instability

If the instability is slow (< 3 Hz), set the OPTION switches in the following order until stability is achieved. Note that switches 2, 3, and 4 should all be ON before beginning.

	SWITCH			
	1	2	3	4
Step 1	ON	OFF	ON	ON
Step 2	ON	OFF	OFF	ON
Step 3	OFF	ON	ON	ON
Step 4	OFF	OFF	ON	ON
Step 5	OFF	OFF	OFF	ON

After each step, readjust the GAIN and STABILITY as described in paragraph 2.0.

If the jumper wire between posts E1 & E2 is missing, replace it. If slow instability still exists, add a small amount of droop by setting the DROOP to 20. Readjust the system per paragraph 2. and the OPTION switch table above.

If slow instability still exists, add a jumper wire between posts E6 and E7 located to the right of the DROOP adjustment. Readjust the system per paragraph 2. and the OPTION switch table. With the jumper between posts E6 and E7, the DROOP adjustment may also be reduced from 20 towards 0. Each time the DROOP is adjusted, the GAIN and STABILITY must be readjusted per paragraph 2.

FACTORY SETTINGS

NOTCH 1 - 0	CRANK TERMINATION - 400	START FUEL RAMP - 50
NOTCH 2 - 2	OVERSPEED - 6400	OPTION SWITCHES
NOTCH 3 - 1 & 2	GAIN - 50	1 - OFF
NOTCH 4 - 3	STABILITY - 50	2 - ON
NOTCH 5 - 3 & 1	DROOP - 10	3 - ON
NOTCH 6 - 3 & 2	ACCELLERATION - 50	4 - OFF
NOTCH 7 - 3 & 2 & 1	DECELERATION - 80	
NOTCH 8 - 1	STARTING FUEL - 15	

TERMINAL DESIGNATIONS and MEASUREMENTS

TERMINAL	DESCRIPTION
A	Magnetic pick-up input. Nominally, the signal should be 5 - 10V AC at operating speed.
B	Ground side of the magnetic pick-up.
C	+24V dc power input from battery supply. Switch and fuse for 10 Amps.
D	Minus side of 24V DC battery supply.
E	Speed test point 5.0V DC when engine is running at the desired speed Below 5V when calling for increased fuel Above 5V when calling for decreased fuel
F	Output to actuator (+) Normal current range for the Cummins EFC is 1.2 - 1.6 Amps. Normal current range for the 275 SERIES is 1.5 - 2.5 Amps.
G	Output to actuator (-)
H	Test point where voltage is proportional to actuator current (4 - 6V DC range)
J	Wheel slip input. When connected to Terminal K, the LCC210A reference speed will be significantly reduced. This reduction may be set with the WHEEL SLIP adjustment.
K	Common input for the 4-wire notch control. It must be connected to the minus side of the battery or the minus side of the 24V that supplies the notch selector switch.
1,2,3,4	4 wire coded reference speed signals. The input current is approximately 3 ma for each wire.
L, M, N	Overspeed form C relay contacts
P, R, S	Crank Termination form C relay contacts

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