# APPLICATION NOTE

KEPCO An ISO 9001 Company.

BOP
001

# Master/Slave Parallel Connection (for more Precise and Stable Control) of Two or More BOP Power Supplies, Remote Sensing

## I — INTRODUCTION

This application note describes an alternative configuration for connecting two or more BOP 100W, 200W or 400W power supplies in parallel, offering more precise and stable control of the output.

## II — THE PROBLEM.

Linear BOP units can be paralleled as shown in Fig. 3-27 and described by paragraphs 3-42 and 3-44 of the BOP Operator's Manual. However, this approach has two disadvantages:

a) Current sharing between master and slave is influenced by the parasitic voltage drop of slave current via the COM connection to the load. If the master does not have remote sensing, its own current also influences the current sharing.

b) The system can become unstable, especially at high frequency, when driving reactive loads or when there are more than two units in a system.

One solution could be setting all units, master and slaves, for remote sensing, regardless of the mode of operation. This can become complicated for more than two units. The slave units in current mode do not really need remote sensing. Also, the system can become unstable, especially for loads situated far from the power supplies.

## III — THE SOLUTION

This Application note eliminates the disadvantages outlined above by using Preamplifier B of the slave units as a non-inverting differential buffer for the feedback/ monitor signal representing the master's current. All the modifications are accomplished making connections among the PC12 programming connectors, as shown in simplified schematic diagram Figure 1 on page 3 for three linear BOP units in parallel, operating in voltage mode, with remote sensing and local control.

To implement the configuration shown in Figure 1 the following modifications must be done to the standard PC 12 Rear Programming Connectors supplied with the unit which have been prewired for local control:

- On the slave units, remove the wire jumpers between terminals (15 and 27) and (4 and 13) of the PC 12 programming connectors.
- On all slave units, install A/B matched pair resistors (20K/20K 0.01%) between terminals 43 and 13 (A) and between terminals 13 and 2 (B) of the PC 12 connector. Install a second matched pair of resistors between terminals 44 and 15 (A), and between terminals 15 and 27 (B).

NOTE: Note that PC 12 terminal 27 is shown in Figure 1 as terminal C (common), available at terminals 23, 25, 27, 29, 31 and 33.

- Use 22AWG twisted pair wires in a daisy chain (master, to slave1, to slave2, . . .) to connect the following PC 12 programming connector terminals:
  a) Between master terminal 27 (C) (black) to slave 1 terminal 43 to slave 2 terminal 43.
  b) Between master terminal 10 (red) to slave 1 terminal 44 to slave 2 terminal 44.
- Slave(s) require local sensing since they are in current mode.
- When the Master is in current mode, use local sensing. When the Master is in voltage mode, use remote sensing.
- Use star-type load connection method, where each unit of the system has its output connected to the load independently.
- On master and slave(s), use the rear panel output terminals to connect the load.
- On master and slave(s), remove the front panel local sensing links. When local sensing is needed, install the local sensing links at the rear panel.
- On slave(s), remove grounding network link at the rear panel and set all slave outputs to floating status.
- On master, install grounding network link at the rear panel.
- If needed, establish a single ground point for the system. If the load is connected to chassis ground, it is recommended that the other system devices (e.g., BOP(s), programming device(s) and monitoring instruments) be floating. If the load is floating, it is up to the user to choose which of the other system devices to connect to chassis ground for best ripple/ noise performance. Multiple ground points degrade the accuracy and stability of the BOP output, and make equipment damage possible if the return connection between BOP and load is lost for a grounded load and grounded programming device.
- Use #22AWG twisted wires or wire pairs that are tied together for remote sensing connections. Always connect the OUT S wire to the OUT wire at the load, and the COM S wire to the COM wire at the load.
- Output power connections must be wire pairs that are either twisted or tied together, and properly rated for the nominal output current of the unit.
- For protection/turn-off interlock of all parallel-connected units, use the appropriate terminals of the PC 12 Rear Programming Connector to configure the Circuit Breaker Control circuit as needed (see Section IV on page 4).

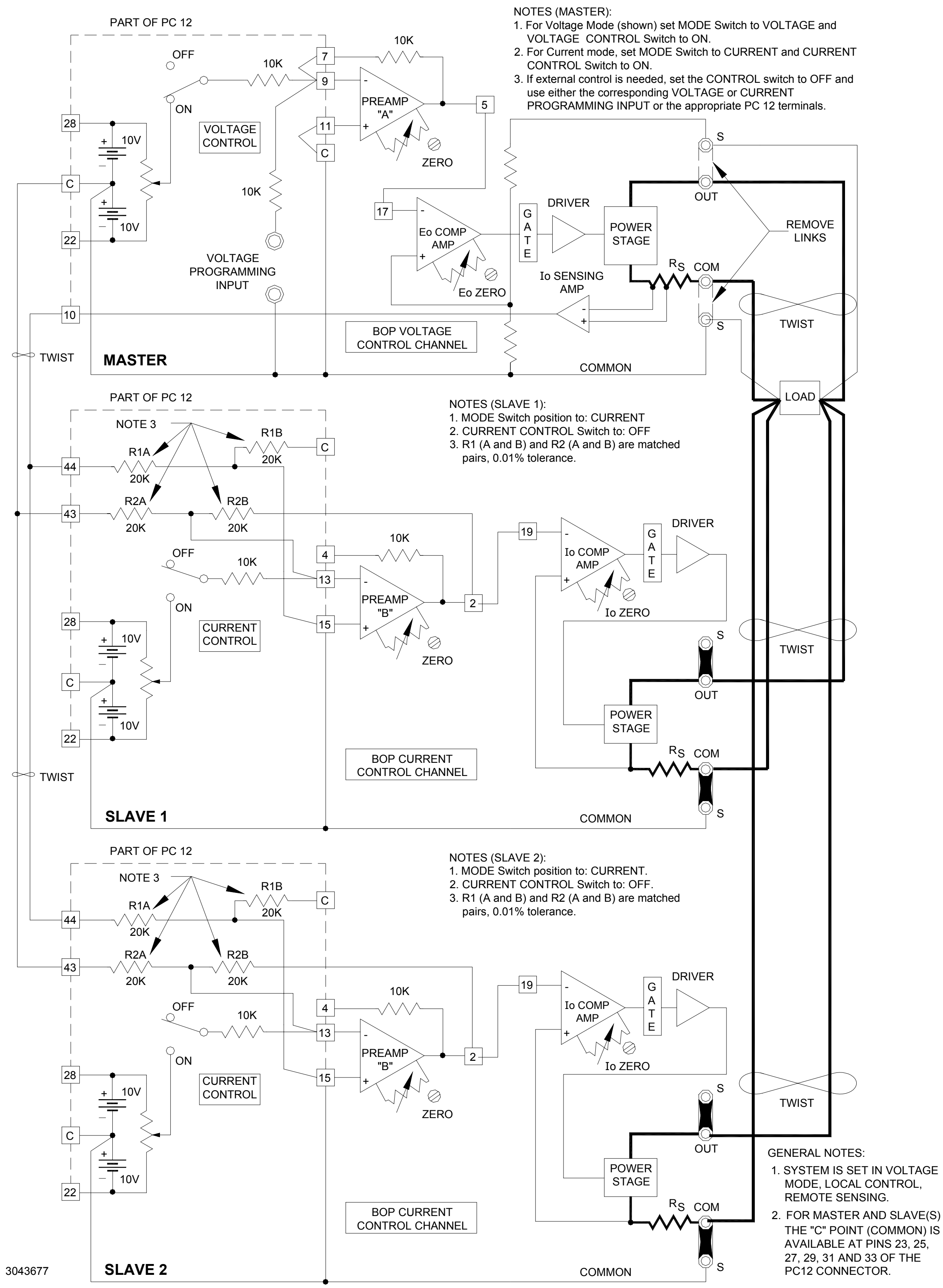


**FIGURE 1. ALTERNATIVE MASTER/SLAVE PARALLEL CONNECTION (FOR MORE PRECISE AND STABLE CONTROL) OF TWO OR MORE BOP POWER SUPPLIES**

# IV — CIRCUIT BREAKER CONTROL CIRCUIT DESCRIPTION

The BOP is protected by the dual-coil circuit breaker/ON-OFF switch (CB101) as shown in Figure 2. The current sensing coil of CB101 is connected in series with the primary winding of T201, thus detecting overcurrents reflected into the primary circuit and subsequently tripping the circuit breaker. The voltage sensing coil of CB101 is connected in series with an SCR (CR4) across the driver collector supply. If the SCR is triggered on, the voltage sensing coil is energized and trips the circuit breaker. The SCR (CR4) can be triggered in several ways:

- On a-c line power loss or interruption, Q1 will loose its turn-on bias first, due to the small time-constant provided in its base circuit (not shown in the simplified block diagram). As a result, Q2 is turned on, energizing the diode in the optical isolator (LC-1) and providing a turn-on signal for the SCR (CR4).
- In the event of an excessive heat rise on the power stage assembly, the thermal switch (S401) will close, energizing the diode in the optical isolator (LC-1) and providing thus the turn-on signal for the SCR (CR4).
- An input signal applied across terminals 49 (+) and 47 (–) of the Rear Programming Connector energizes the diode in the second optical isolator (LC-2) which, in turn, energizes the diode in the first optical isolator (LC-1), thus providing for SCR turn-on.

NOTE: Upon turn-off, an isolated output signal is available at Rear Programming Connector terminals 26 (+) and 36 (–). This output signal can be used to turn off other equipment when the BOP is turned off. As an example, applying it across terminals 49 and 47 of the Rear Programming Connector of a second BOP allows the master of a parallel or series configuration to turn off the slave when the master is turned off.

- A manual, non-isolated turn-off is provided which, when implemented with an external switch contact as shown in Figure 2, will energize the diode in the first optocoupler (LC-1). thus providing the SCR turn-on.
- If it is not desired to trip the circuit breaker (CB101) upon a-c line power loss, it can be prevented by a jumper wire or an external switch across terminals 24 and 25 on the Rear Programming Connector. In this manner, Q1 is inhibited from providing a turn-on signal for Q2, thus avoiding triggering the SCR and tripping the circuit breaker.

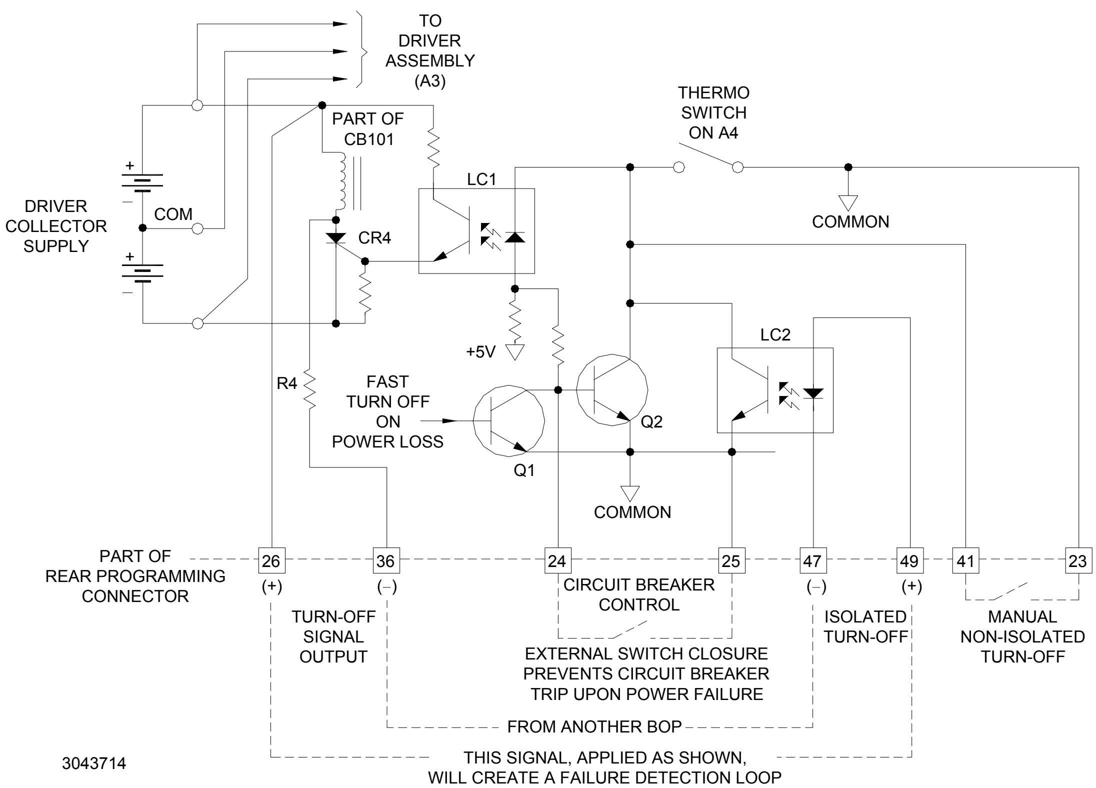


**FIGURE 2. CIRCUIT BREAKER CONTROL CIRCUIT, SIMPLIFIED DIAGRAM.**


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