CEYX® LCD Backlighting Control

Introduction

The CEYX® LCD backlighting control is set of circuits and methods used to control cold cathode fluorescent lamps (CCFL). Control of the lamps is carried out with a Software Enabled Control System, which is at the forefront of developments in the field of Controls and Computer Science. The control system allows multiple lamps to be driven out of the same inverter circuit while preserving the independent dimming control for each lamp. The control system is adaptive in that it compensates for aging, operating temperature, lamp manufacturing variations. The result is equalized lamp brightness for systems such as LCD displays that require multiple lamps and where all lamps must produce the same level of intensity.

Traditional Implementations

A typical inverter and lamp circuit is shown in Figure1. The inverter PCA contains analog circuits consisting of a Mosfet switch, a coil, a push-pull driver circuit, a tuning capacitor, a transformer and a ballast capacitor. The function of the analog circuits in the inverter is to convert a DC voltage input into an AC voltage at the output. The inverter is connected to a lamp circuit consisting of a fluorescent lamp, a potentiometer, a current sense resistor and a rectifier diode terminal of the potentiometer is connected to the inverter controller, which is also part of the lamp circuit.

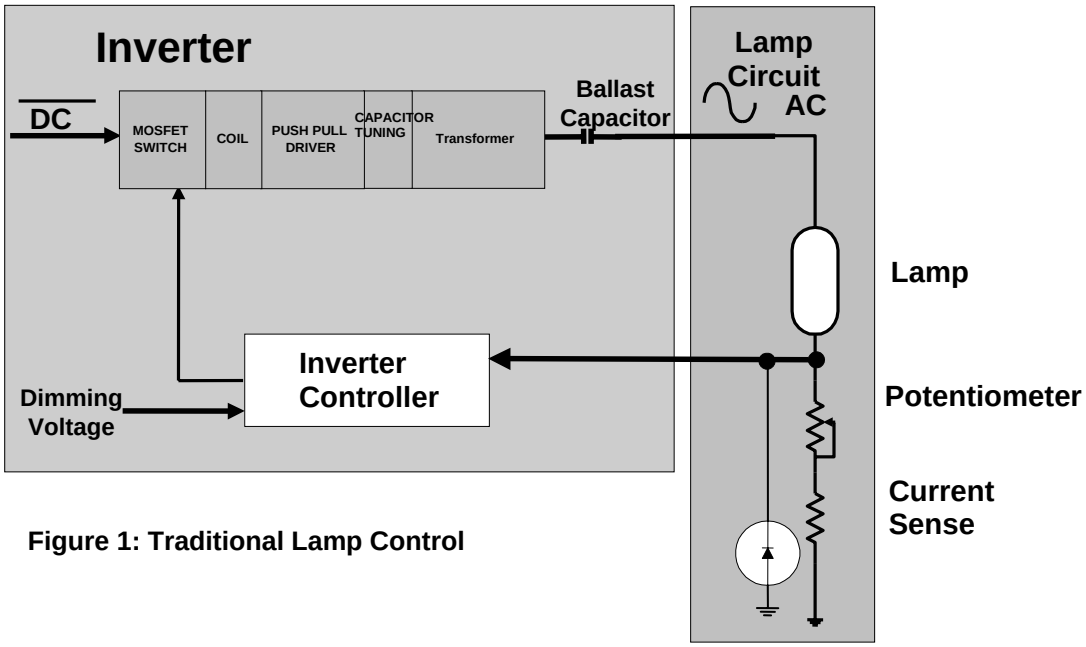

Figure 1: Traditional Lamp Control

The inverter controller receives the current sense and dimming input signals and generates an appropriate output for the inverter to produce the required AC voltage needed to drive the lamp.

Some disadvantages of the traditional lamp control are:

1. Requires manual adjustment of potentiometer to compensate for component manufacturing variations
2. Limits compensation for aging of the lamp
3. Does not allow for independent dimming of each lamp. This forces the user to utilize one inverter per lamp in critical applications.
4. Limits easy inverter design leverage between product generations

The CEYX® Solution

The CEYX® solution consists of three elements

- Software Enabled Control System
- Embedded Control Algorithms
- CCFL control Hardware

Software Enabled Control System

Figure 2 illustrates the configuration for a Software Enabled Control System. To create a new application, a Host Computer retrieves configuration data from its database and places the appropriate information into a Configuration memory, which is part of an Embedded Control System. By changing the Configuration, the control system then is able to apply control in the most optimal manner to the System Under Control. Examples of Configuration data are parameters for embedded equations, firing voltage for a lamp and information regarding electronic circuit connections and sensors.

Once the configuration is complete, the Embedded Control System is able to operate on its own without any assistance from the Host Computer in the most optimal manner to the System Under Control

These configuration advantages allow CEYX® to address CCFL lamp controls in a flexible manner. For example, the configuration can contain various parameters, which provide specifications for a type of lamp and even for individual lamps if necessary. The control system will then optimize the control to best drive the system under control.

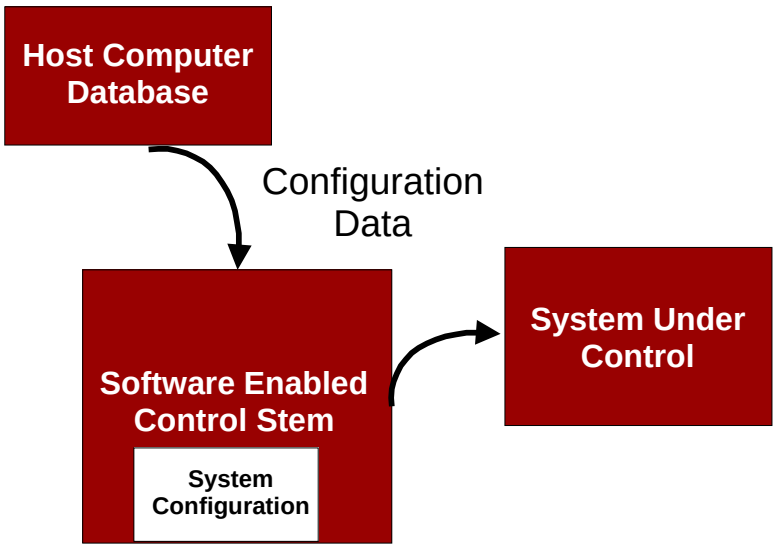

Figure 2: Software Enabled Control System

Embedded Control Algorithms

The embedded Control Algorithms consist of a suite of servo control algorithms and methods implemented in a variety of control processes. The key components used specifically for CCFL controls are:

- Servo Control Method
- Expert firing voltage detector
- Output intensity control servo

The **Servo Control Method** contains various elements:

- The forward path consists of a special Servo Controller that is most appropriate to the CCFL lamp; a lamp Drive model consisting of the transfer function for the inverter; and an electrical model for the lamp.

- The feedback path contains one or more sensors. Current sensor is usually sufficient for cases where the current provides adequate information to determine the lamp output. If there are other constraints to the CCFL lamp controls such as fine intensity lamp adjustments or extreme temperature operating conditions, the Servo Control may receive other information such as Light Intensity and Temperature sensor data. In order to properly use the Sensor information there is the need to use Signal Processing in order to determine with the necessary level of precision the sensor information.
- Servo input. The SET input determines what is the required OUTPUT. In this case it is light intensity. A comparison is made between the SET input and the FEEDBACK from the sensor(s) and the error is given to the CEYX® Controller.

Expert Firing Voltage Detector

This feature has two steps:

1. Turn on the lamps by applying the appropriate firing voltage as prescribed in the system configuration. This step is accomplished by having the CEYX® controller send the appropriate signal to the inverter to produce the firing voltage.
2. Once the lamps are turned on, the output intensity for each lamp is determined by servo control.

Output Intensity Control

Use of Servo controls offer numerous advantages:

- Since there is continuous monitoring and adjustment of the OUTPUT, the result is very precise.
- The various elements of the block diagram can be calibrated to a high degree of precision with an automatic calibration.
- Also, the various blocks of the servo can be configured with the Software Enabled Control System methods, so variations in lamp types or lamp control approaches can be incorporated.
- Other embedded algorithms facilitate sensor signal processing.

Figure 3 below illustrates a model for Servo Control of the lamp output.

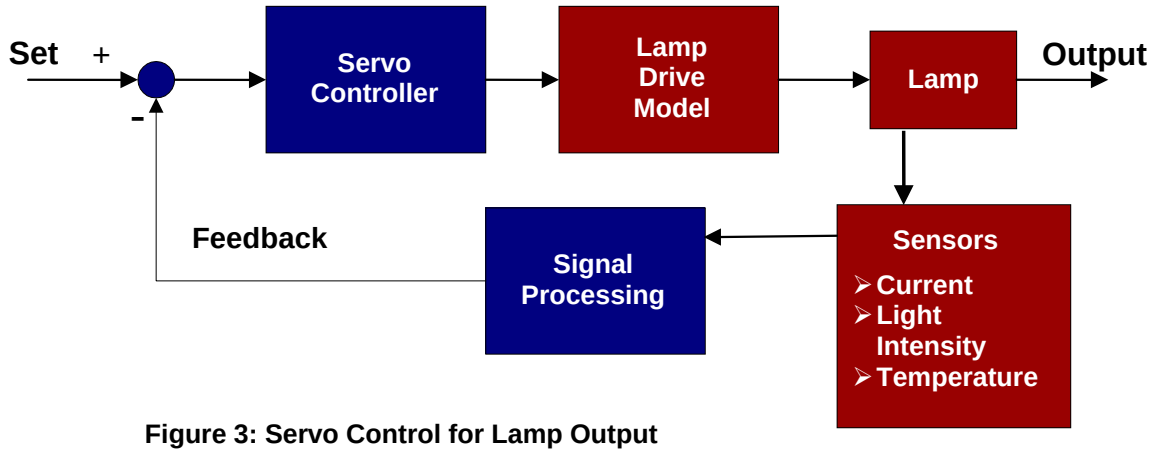

Figure 3: Servo Control for Lamp Output

CCFL Control Hardware

The simplified control hardware permits the flexibility provided by the Software Enabled Control System. Figure 4 shows an example of a possible implementation.

The approach of using Software controls enables very rapid development because it emphasizes firmware functionality geared to provide flexibility and lower costs (see Figure 4 hardware outlined in red). Any platform can be supported along with appropriate multiple types of sensors and inverter circuits.

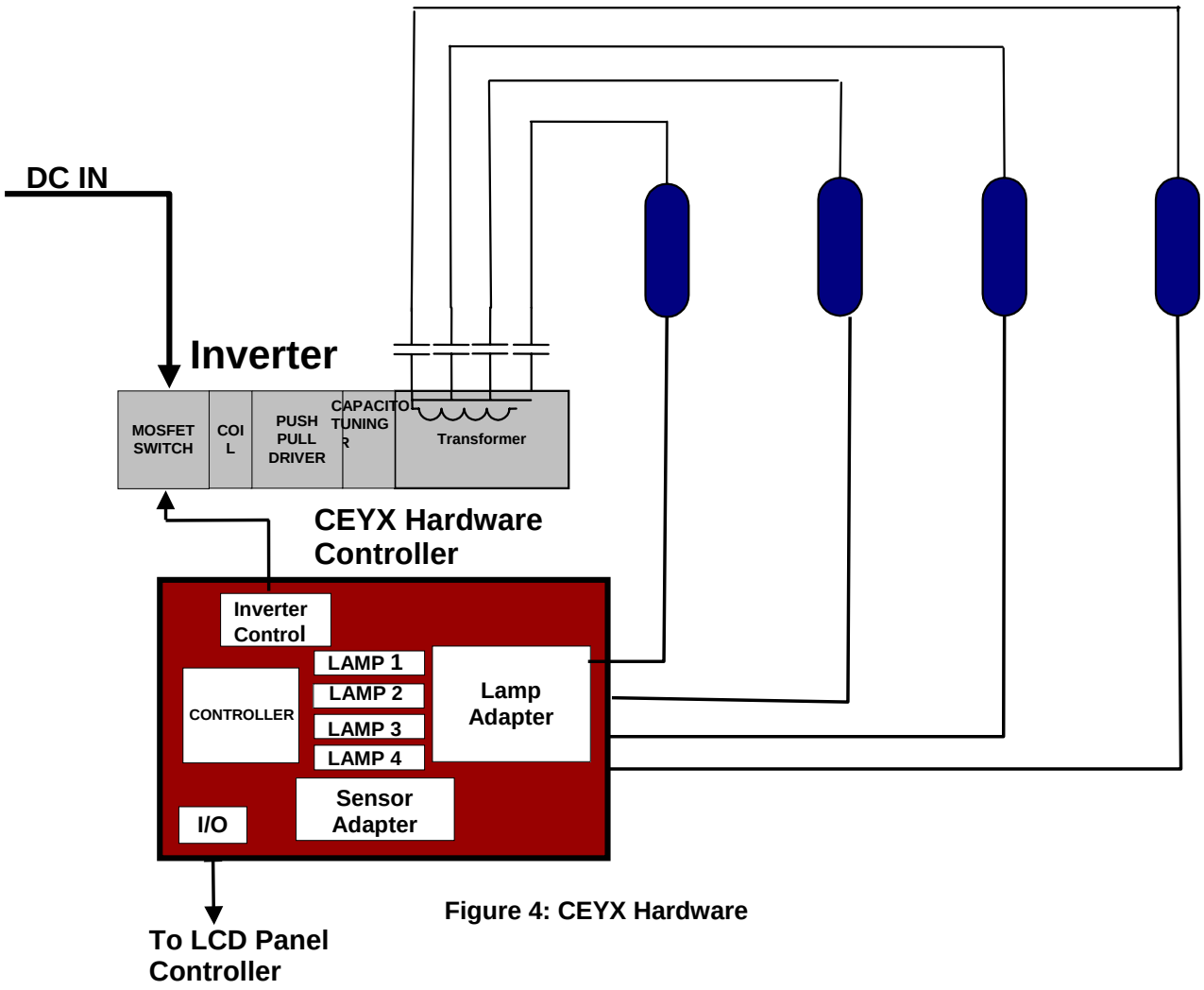

Figure 4: CEYX Hardware

Advantages of the CEYX® Control System

- Cost reduced circuit architecture. Reduce cost of lamp circuits by reducing the number of inverters and transformers.
- Drive several lamps using only one inverter analog circuit and transformer.
- Precise light intensity control
- Equalization of intensity across all lamps
- Aging compensation
- Failure prediction with built-in diagnostics
- Configurable to many types of lamps
- Temperature sensor and photodiode maintains performance over all temperature conditions
- Eliminates manual adjustments in manufacturing by manufacturing test automation
- Can use broader spread of lamps given manufacturing variations

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Data subject to change