

Bourns® Linear Motion Potentiometers: 3046 & 3048 ***Digital Circuit Application Note***

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Introduction

Microcomputer engineering is a driving technology for the electronics industry worldwide. Digital electronic circuits are responsible for many of the consumer and industrial products used today. Their use of voltage representation as binary signals helps to reduce the problems with inaccurate components, temperature and age effects.

Digital circuits can be designed using a control unit. It provides an easier way to change a design if new algorithms are required. A single-chip microcomputer is ideal for controlling mechanical and electrical devices.

The purpose of this document is to demonstrate the function of the **Linear Motion Potentiometer (LMP)** as a position sensor for a 32-bit microprocessor-based system.

Implementation of Bourns® LMP into Digital Systems

Bourns® LMP products may be used as a cost-effective solution to improve or modify an existing system. For illustration purposes, this example will show how a home sprinkler system can be modified to have water-conservation capability.

The Adaptation

System Feasibility

For simplification purposes, let us consider the application of a smaller local system, such as the sprinkler system already installed in a house unit. The specific application is to improve an existing sprinkler system of a house and implement a microcomputer-based controller. This system will determine the operation of the sprinkler system based on rainy and normal conditions.



Figure 1. The application of a weather monitor for irrigation control

APPLICATION NOTE

A funnel system can be used to collect rainfall from a rain gutter. This adaptation shall be to define rainfall by linear displacement of a floating device inside the funnel. A 3046 linear motion potentiometer will be connected as a voltage divider, as shown in Figure 2. It will operate as a position sensor such that the mechanical displacement of a floating device inside a funnel shall be converted to a proportional voltage output.

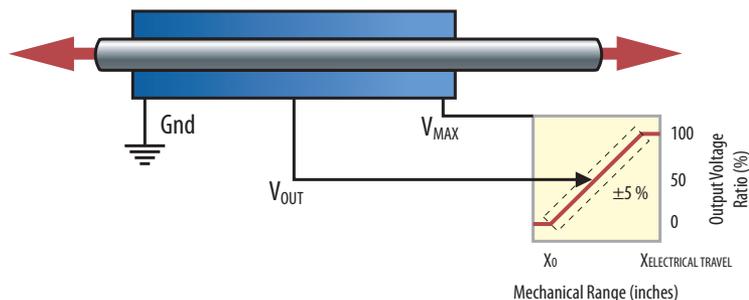


Figure 2. Functionality of the 3046 Linear Motion Potentiometer

The voltage output signal is connected to a comparator and serves as a digital conversion from analog data, as shown in Figure 3. At the comparator, the following conditions will apply:

If $V_{REQ} > V_A$, FULL = Logic 1.
Else, FULL = Logic 0.

That is, when the funnel is FULL, the maximum electrical travel will be reached. Once the corresponding output voltage is obtained, the comparator will send a Logic 1 signal to the interface. Otherwise, it will send a Logic 0.

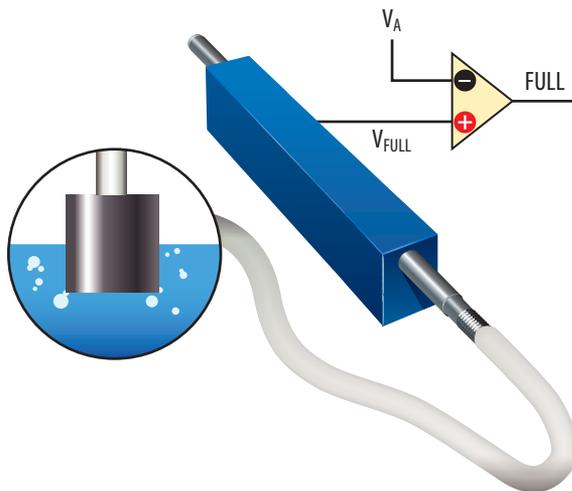


Figure 3. The 3046 position sensor and its connection to a comparator

32-bit Microcomputer-based System

The basic system is shown in Figure 4. The timer switches the sprinklers on/off at predetermined times. It will be modified so that the controller shall determine the current status of the sprinkler system. The 3046 LMP will be used to detect the measurement of collected rainfall based on the voltage output signal. The levels of rainfall will determine if the sprinkler shall continue with normal operation or reset for the next day.

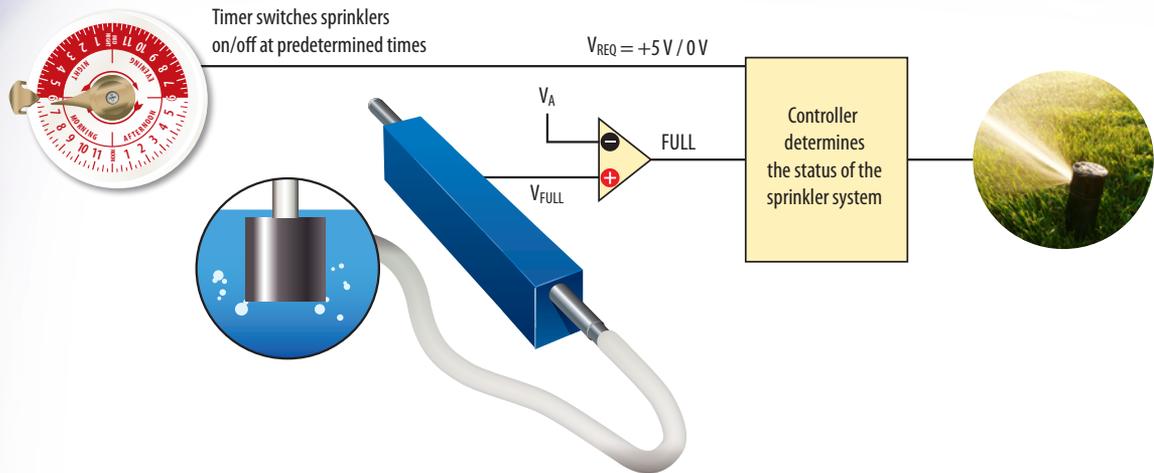


Figure 4. The basic system

The microcontroller will be programmed to meet the following elemental conditions:

- Wait for “On” signal → Set “Rain” flag as needed
- Wait for “Off” signal → Read flag; set as needed

External Interrupts

For this example, the microcontroller is a 68020/68230-based microcontroller. The 32-bit microprocessor has seven levels of external interrupts (0 – 7) via pins IPL0, IPL1, and IPL2, which will be used for the elemental conditions. It will operate so that if the value of IPL0, IPL1, and IPL2 is greater than the current interrupt mask, 68020 acknowledges and initiates a request. Otherwise, it continues with the current interrupt.

The status of the sprinkler system will be either at FULL (funnel is full), RUN (sprinklers are turned on), or END (sprinklers are turned off). Based on the inputs FULL, RUN or END, the system will be in one of the following modes:

- Normal Mode
- FULL Mode
- RUN Mode
- END Mode (Highest Priority)

For any reason, if the sprinklers need to be turned off, END Mode has the highest priority. FULL mode has a lower priority than RUN and END so that if it rains more than once during the day, the system will not continue to be set off by that signal. It will already be programmed not to turn on for the next day.

System Block Diagram

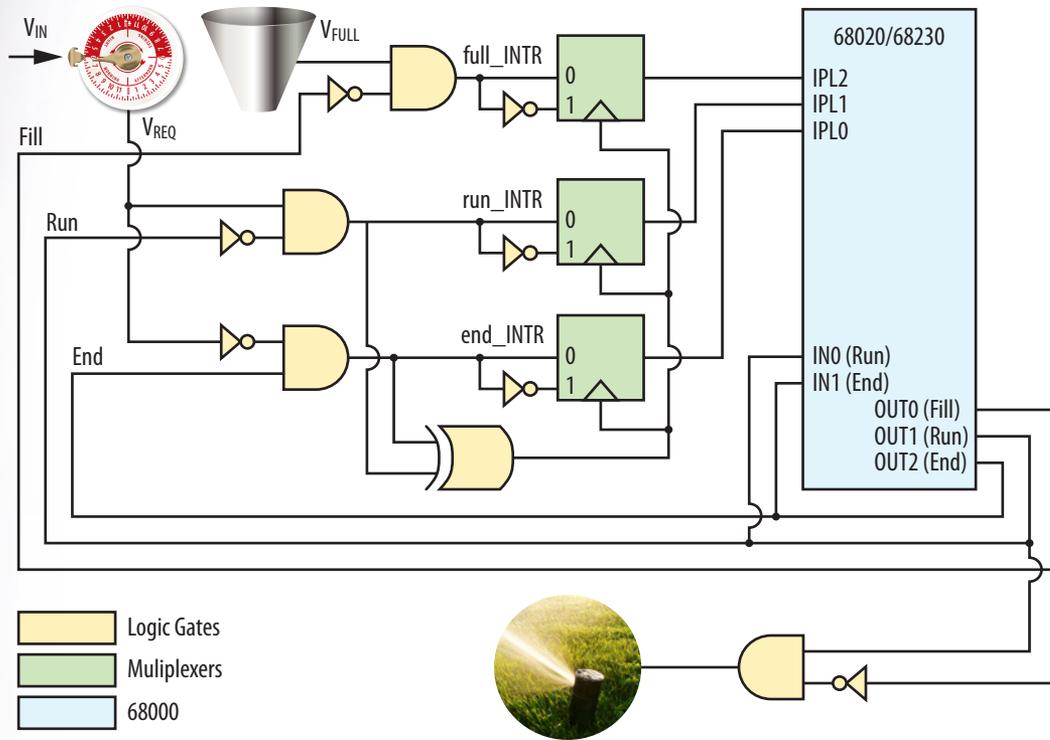


Figure 5. A general block diagram showing alterations to the basic system to implement the application

Derive Logic

Table 1 shows the logic gates and their connection configuration. The white boxes show the mode interrupts with each corresponding priority. The green boxes show the state of the lines when the white boxes are true. The blue boxes show the necessary input to the interrupt pins.

INTR for	Priority	full_INTR	run_INTR	end_INTR	!IPL2	!IPL1	!IPL0
Full	4	1	0	0	0	1	1
Start	5	0	1	0	0	1	0
End	6	0	0	1	0	0	1
Normal	0	0	0	0	1	1	1

Table 1. Derivation of the logic and priority levels of the interrupts

The purpose of priority levels is to eliminate the FULL MODE every time it rains.

Software Algorithm

Based on the previous conditions discussed earlier, the 68020/68230 microcomputer will perform the following:

*Using a position sensor on a funnel, if $V_{REQ} > V_A$, funnel is FULL (HIGH);
Otherwise, funnel is NOT FULL (LOW). Input FULL via bit 0 of Port A.
Drive LED via bit 5 of Port B.*

APPLICATION NOTE

Using a timer with a switch connected to the sprinkler system, RUN sprinkler if switch input is HIGH; Otherwise, END sprinkler. Input switch via bits 1 and 2 of Port A. Drive outputs via bits 6 and 7 of Port B.

The auto vector level maskable interrupts are used with four priority levels as follows:

Priority Level 0.

Normal Interrupt: Bits 0, 1, and 2 of Port A are LOW.

Priority Level 4.

Full Interrupt: Bit 0 of Port A is HIGH.

Priority Level 5.

Start Interrupt: Bit 1 of Port A is HIGH.

Priority Level 6.

End Interrupt: Bit 2 of Port A is HIGH.

The software can be written using 68000 assembly language. In order to use autolevel vector interrupts, it should be noted that the AVEC pin of the 68020 is needed to enable them. Further note, an alternative design would be to use an EPROM to determine the current level of priority. For this system, a 74HC148 8-to-3 Encoder can be utilized to set up the interrupt. Also, rather than using an actual timer, an alternative is to use a software timer, such as a counter.

Validate Total System Operation

There are key benefits of using a linear motion potentiometer in a digital system. We have shown how to modify an existing system, such as a home sprinkler. This application is feasible for expansion of a prototypical scheme. It can also be integrated with larger systems, such as the weather irrigation for a neighborhood. Ultimately, it provides the potential to expand with multiple wider systems and can adapt to many other applications.

There are endless possibilities that can integrate Bourns LMPs as part of an embedded circuit design. A spin-off of the trimming potentiometer product line, the linear motion potentiometer was developed to meet the needs of designers wishing to detect linear movement of position.

Other applications for these compact components include, but are not limited to:

- Solenoid positioning sensors for automated controllers
- Volume control on audio equipment
- Joystick controllers
- Satellite dish positioning
- Robotics

For information on a Bourns® LMP Design Kit, please contact your local Bourns sales office or authorized Bourns distributor.

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