Reference Design

Current Sensing Power Switch SCR with ZMOTION® Control

RD002302-0814

Overview

This reference design integrates a ZMOTION® Detection Module II and an AC Power Switch Relay based on the IXYS CPC1966 Module to create a motion-controlled current-sensing power switch. The CPC1966 Module includes dual, optically-isolated SCR outputs with enhanced zero-crossing detection circuitry to minimize load distortion. The ZMOTION Detection Module II is based on Zilog's Z8FS040 MCU to provide a 5m (on-axis) and 6m (60-degree off-axis) detection pattern.

After motion is detected, the AC switch is activated, providing power to the load until 30 seconds after motion stops, at which time the AC switch is deactivated. The hardware and software components in this reference design can be used as a basis for developing motion-controlled power-switching solutions.

Note: The source code file associated with this application note, RD0023-SC01, is available free for download from the Zilog website. This source code has been tested with ZDSII – Z8 Encore! 5.0.0. Subsequent releases of ZDSII may require you to modify the code supplied with this application note.

Features

This Current Sensing Power Switch SCR with ZMOTION Control reference design offers the following features.

- 90–240V AC RMS input voltage range
- Up to 3A load current
- Overcurrent protection
- Adjustable minimum drop-out current protection
- Less than 2mA standby current at 120V AC in an OFF state

Potential Applications

The motion-controlled current-sensing power switch can be used to develop a number of applications, including the following examples:

- Occupancy-controlled commercial or architectural lighting
- Motion controlled night-lighting within the home or medical care facility

Discussion

This Current Sensing Power Switch SCR with ZMOTION Control Reference Design includes the ZMOTION Detection Module II with Fresnel lens, as shown in Figure 1. The Base Power Board is a two-layer surface-mount board that provides easy probe access points to all inputs and outputs, allowing the user to quickly connect and measure electrical characteristics and waveforms. The Base Power Board also contains Zilog's Z8F2480 MCU, which is used to generate pulses to keep the CPC1966 Switch active, perform current sensing (i.e., to detect the optimal SCR pulse position and to monitor for over/under load current conditions) and monitoring to detect motion signals from the ZMOTION Detection Module II.



Figure 1. The Current Sensing Power Switch SCR with ZMOTION Control Reference Design with a ZMOTION Detection Module II

The Base Power Board and attached ZMOTION Detection Module II are powered from a single-phase AC line with a 90–240 V voltage range. The Base Power Board provides up to 3 A load current at 240 V AC RMS. The dimensions of the Base Power Board are 2.85" (L) x 1.85" (W) x 0.7" (H). A block diagram of the Board is shown in Figure 2.

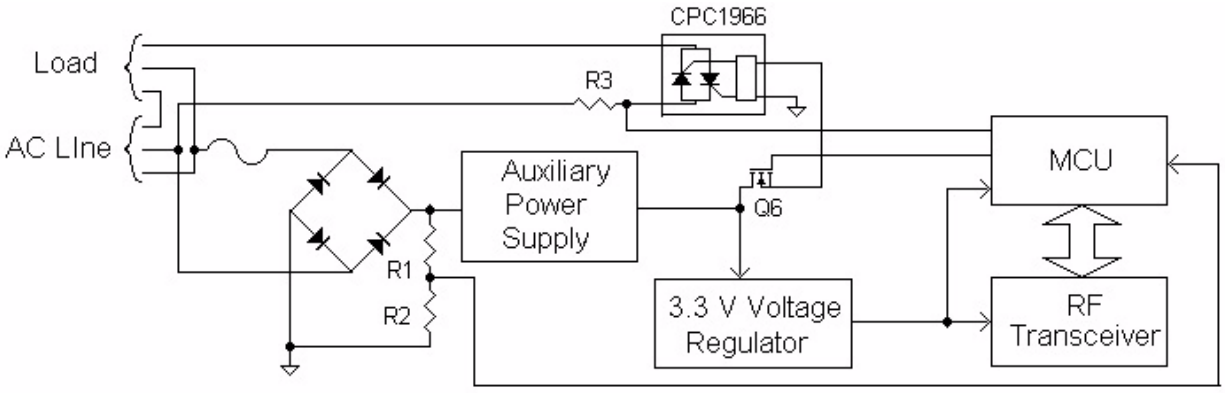


Figure 2. A Block Diagram of the Current Sensing Power Switch SCR with ZMOTION Control Reference Design with a ZMOTION Detection Module II

Warning: The Base Power Board is electrically connected to AC power and contains points with high voltage (up to 400V). If any measurements will be performed on the Base Power Board, a power supply with an isolation transformer should be used to avoid electrical shock. Persons working with this Base Power Board should be fully qualified to work with high-voltage devices.

Base Power Board

The Base Power Board, shown in Figure 3, contains an auxiliary power supply[1] with Depletion Mode MOSFET Q1 (IXTA08N50D2), Zener Diode ZD1, resistors R1 and R2, and Switch Q2 with resistors R16 and R19, which are operated by the MCU. The Board provides approximately 13V to drive Voltage Regulator U1 with 3.3V output to power the MCU and the RF block.

MOSFET Q6, connected to the optical input of the CPC1966, turns the Board ON after a pulse from the MCU is received.

1. Patent pending

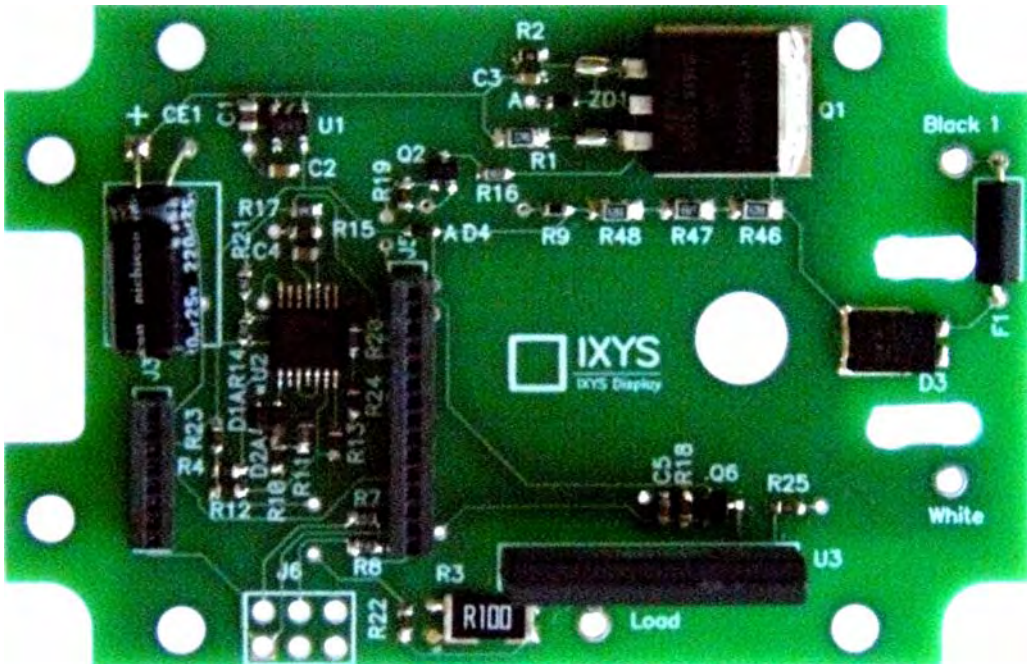


Figure 3. Power Switch Base Power Board, Top View

Resistive divider R46–R48/R9 provides signal to the MCU's first internal comparator to determine the moment of AC voltage zero crossing, while current sense resistor R3 with signal conditioner (U2A-C,Q3) provides a signal to a second comparator to determine the AC current zero crossing. Comparator U2D functions as overcurrent protection, providing the MCU information about every overcurrent event.

Debug connector J6 is for factory use only, and is not assembled on the Base Power Board.

ZMOTION Detection Module II

The ZMOTION Detection Module II, shown in Figure 4, features a Z8FS040 MCU with a pyroelectric sensor and a low-profile Fresnel lens. To learn more about the ZMOTION Detection Module II, please refer to the ZMOTION Detection Module Product Specification (PS0305).

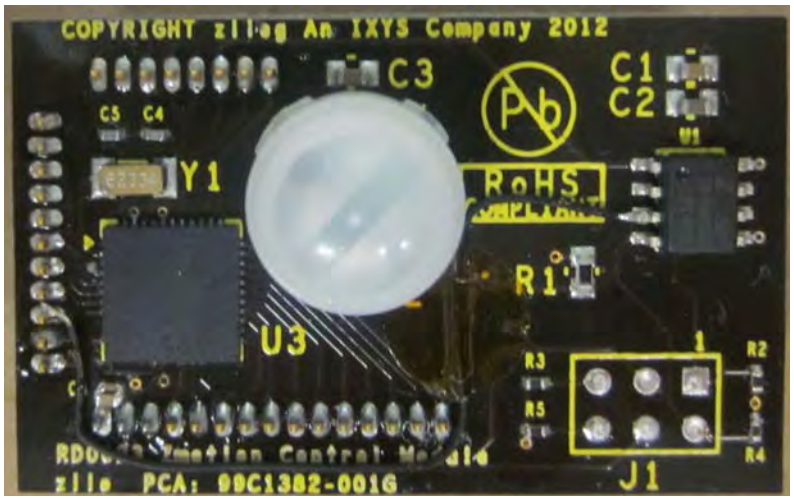


Figure 4. The ZMOTION Detection Module II

Principles of Operation

After power-up, the auxiliary power supply provides approximately 13V, which starts the 3.3V voltage regulator and powers the Z8F2480 MCU. After the MCU becomes active, it begins monitoring the voltage on resistor R9 (half-wave rectified main voltage) through a comparator on the Z8F2480 MCU. After monitoring three comparator edges, the MCU estimates the period of the AC signal and the approximate point of the AC voltage zero-crossing. The MCU then generates an initial pulse to activate the CPC1966 Power Switch at the next voltage zero crossing.

The CPC1966 Switch will continue to supply power to the load as long as the Z8F2480 MCU continues to generate pulses at every AC current zero-crossing. Therefore, after activating the initial pulse at the AC voltage zero-crossing, the MCU starts monitoring AC load current zero-crossings to keep the U3 CPC1966 Switch conducting when there is a phase shift between AC voltage and load current due to load impedance.

After initially activating the load, the MCU begins monitoring the motion signal from the ZMOTION Detection Module II. If no motion is detected after approximately 30 seconds, the MCU stops generating pulses, which deactivates the CPC1966 Switch at the next AC current zero-crossing. Each time motion is detected, the time-out period is extended by 30 seconds. If motion is detected while the CPC1966 Switch is OFF, the MCU will repeat the voltage detection phase prior to monitoring for AC current zero-crossings. This process of initially activating the switch at voltage zero-crossing and continuing to pulse the switch at the current zero crossing minimizes surges in load current.

While the Power Switch is ON, the Z8F2480 MCU samples the load current through an ADC input to monitor for over/under current events. If the load current exceeds 3A RMS for more than eight consecutive AC half-waves (approximately 80ms at 50Hz, or 67ms at 60Hz), the MCU stops generating pulses to turn OFF the CPC1966 Switch. This delay between overcurrent detection and deactivating the switch allows time for sudden changes

in load current to dissipate before the switch is deactivated. If the load current falls below approximately 300 mA RMS, the MCU turns the Power Switch OFF to reduce the power consumed by an idle load. Low-load current detection is also performed every AC half-cycle while the switch is ON; after four consecutive undercurrent detection events, the MCU will deactivate the switch.

After the Z8F2480 MCU deactivates the Power Switch due to an over/under load current, the next motion detection event will cause the MCU to reactivate the switch, an event that may result in a perceived flickering of any lights controlled by the Power Switch, and alerting a technician to the over/undercurrent detection event.

Software Description

There are four primary operating modes of the Power Switch firmware:

- Startup: contains the Reset and LP_Startup states
- Off: contains the OFF state
- Turning-on: contains the Voltage Zero Crossing (V-ZC) state
- On: contains the Current Zero Crossing (I-ZC) state

Table 1 summarizes the operating characteristics of each software state within these primary modes of operation; all are further described in this section.

Table 1. Operating Characteristics of Each Software State

Software State	Operating Characteristics
Reset	Configures the CPU's operating frequency, peripherals and GPIO pins based on the source of the hardware reset event.
LP_Startup	The system is configured in its lowest power consumption mode for approximately one second to allow external circuitry to stabilize before attempting to control the Power Switch.
OFF	The AC Power Switch is OFF; TMR 1 is active (220 ms period). Motion detection is performed approximately every 220 ms. Software remains in this state until motion is detected.
V-ZC	AC Power Switch OFF, TMR1 active, TMR2 active, software monitors V-Edge to find AC mains voltage zero crossing. Software typically in this state for approximately 2 AC cycles after motion is detected.
ON	The AC Power Switch is ON (i.e., TMR0 is active), TMR1 and TMR2 are active, and software monitors the I-Edge to find the load current zero crossing. Load current is monitored to ensure that it remains within limits. Software remains in this state up to 30 seconds after motion detect signal goes idle.

Figure 5 depicts a state transition in the Current Sensing Power Switch SCR with ZMOTION Control.

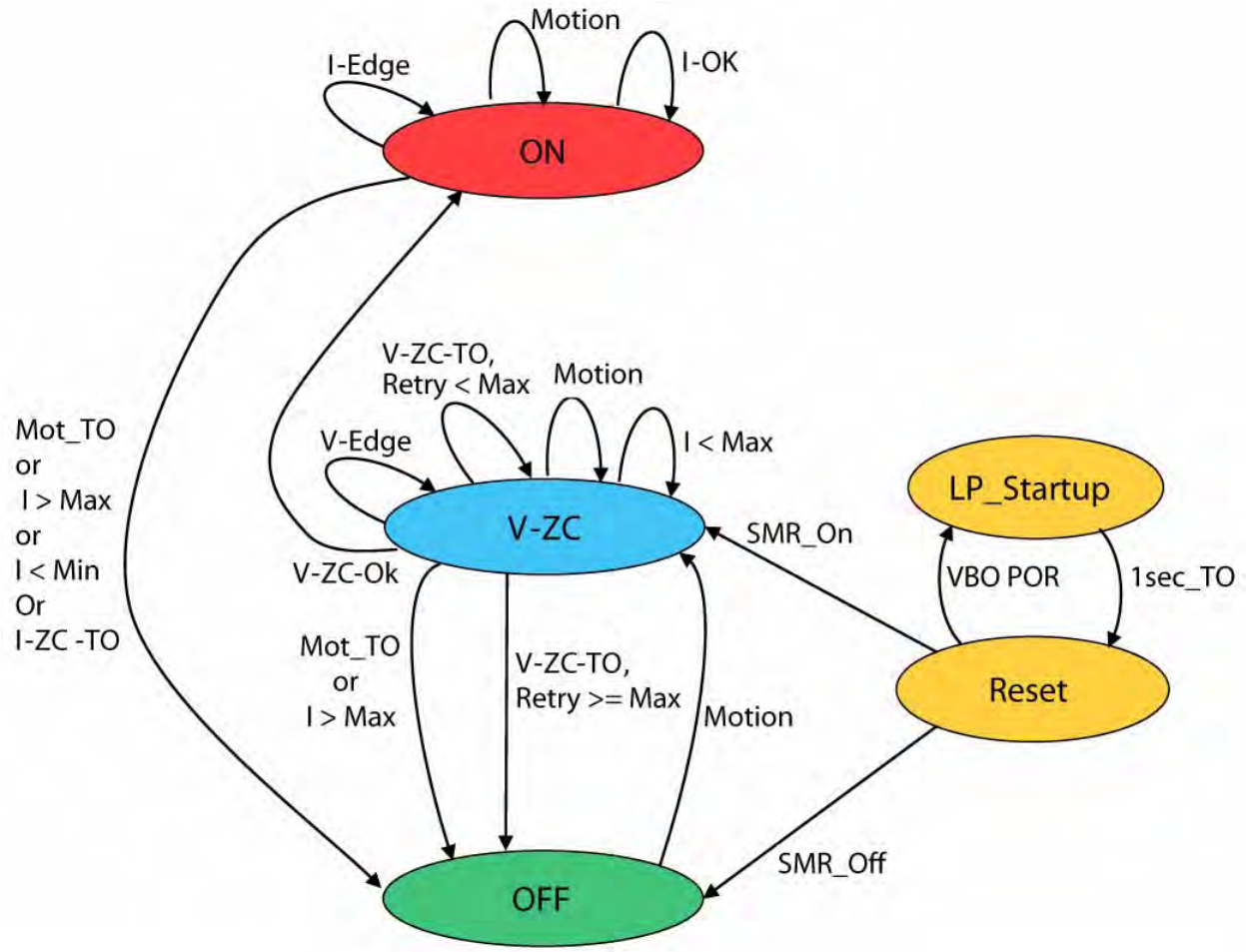


Figure 5. Current Sensing Power Switch SCR with ZMOTION Control State Transition

Reset and LP_Startup States

After the 3.3V regulator becomes operational, the Z8F2480 MCU goes through a hardware reset cycle, then begins executing firmware in the Reset state that determines the source of the reset. A power-on-reset causes the system to transition to the Low Power Startup state, in which the CPU operating frequency is reduced to approximately 43kHz, unused peripherals are powered off and unused GPIO pins are set to low-level outputs. A timer running off the external 32kHz oscillator is then configured to generate a one-shot time-out after approximately one second. The CPU is then placed into its lowest power operating mode (i.e., Stop Mode) until the one-shot timer causes the system to transition back into the Reset state. This delay allows sufficient time for all external circuitry to stabilize before attempting to activate the Power Switch while minimizing MCU power consumption.

After the one-second time-out, the Reset handler determines that the cause of the reset is due to a Stop Mode Recovery (SMR) event. The reset module then sets the CPU operating

frequency to 1.38MHz and enables all peripherals (and GPIO pins) for normal operation. The system is then transitioned to either the OFF state or the Voltage Zero Crossing (V-ZC) detection state, depending on the setting of a configurable value in Flash memory. The default setting is to transition to the V-ZC state for the purpose of activating the Power Switch.

OFF State

While the Power Switch is in the OFF state, PA1 is held High, thereby blocking the load current through the Power Switch. In the OFF state, the Z8F2480 MCU is typically in a low-power mode (i.e., Halt Mode) and only executes code after an interrupt signal occurs (see the Software Events section on page 11). Whenever the system is in a non-startup state, TMR1 generates a periodic interrupt every 220ms to allow the main routine to monitor the motion detect signal every 220ms. If the motion detect signal is active, the system transitions to the V-ZC state.

V-ZC State

In the Voltage Zero Crossing (V-ZC) state, software continues to monitor the motion detect signal and must also monitor PD3 edges (i.e., the V-Edge signal) to estimate the period and zero crossing of the AC mains voltage. This state also requires the use of another timer (TMR2) to monitor failed V-ZC detections (i.e., the V-ZC-TO signal). As with the OFF state, the CPU is idled (i.e., enters Halt Mode) until an actual event occurs to minimize current consumption.

Upon entering the V-ZC state, the software waits for the C1 output to stabilize (either High or Low), then enables PD3 edge interrupts. Because the main voltage is half-wave rectified, after three V-Edge signals occur (after approximately 1.5 to 2 periods), the software has enough information to calculate the AC period and estimate the location of the voltage zero crossing (i.e., the V-ZC-OK signal in the state diagram). At 50Hz, two periods should occur within 40ms, which is used as the TMR2 time-out period. If TMR2 expires before the software determines V-ZC-OK, then the V-ZC-TO signal has occurred. In this instance, the software will retry the voltage zero crossing detection until the number of retries exceeds Max (defaults to 10). If the software is unable to determine the AC Voltage Zero Crossing, the system transitions to the OFF state, in which it waits for another motion detection signal. If the V-ZC-OK signal is detected, the software transitions to the ON state.

ON State

Upon entry to the ON state, the software configures TMR0 for PWM Mode (using the period obtained in the V-ZC state) to generate negative pulses on PA1. In addition, the PD3 (C1 output) interrupt source is disabled (suppressing the half-wave rectified V-Edge signal) and the PA0 falling edge interrupt source is enabled. PA0 is a full-wave rectified digitized representation of the AC load current. PA0 goes Low just before the actual load current zero crossing, and goes High just after the current zero crossing. TMR2 continues to run to provide a watchdog time-out for current zero crossing detection (I-ZC), and provides a timing reference for measuring the duration of the load current zero crossing. Within the PA0, edge interrupt software reads the current TMR2 count to obtain a time-

stamp, then modifies the Interrupt Edge Select Register to trigger another interrupt on the opposite edge polarity.

After completing the transition to the ON state, the PWM timer will automatically generate SCR pulses at the estimated midpoint of the voltage zero crossing. For a perfectly resistive load that exhibits no temperature effects, the TMR0 could remain in PWM Mode indefinitely to provide reasonably accurate pulses close to the midpoint of the zero crossing. However, for reactive loads (or even resistive loads with operating characteristics that vary with temperature), continuing to use the voltage zero crossing reference is not suitable. To keep the SCR conducting, it is necessary to activate the SCR pulses near the midpoint of the current zero crossing.

Consequently, the software only leaves TMR0 configured in PWM Mode, thereby generating SCR pulses at the midpoint of the voltage zero crossing, until two current zero crossings are detected (i.e., PA0 is observed going Low, then going High, over two AC half-cycles). At this point, PA0 interrupts are disabled and the software reconfigures TMR0 for Gated operating mode to provide better accuracy in the position of the SCR pulse. In Gated Mode, TMR0 only counts while PA0 is Low (i.e., during the current zero crossing). The timer generates an interrupt when PA0 goes High (i.e., at the end of the current zero crossing) and upon each timer reload while the timer is active. When a timer reload event occurs, the timer output pin (PA1) changes state. Each time TMR0 is suspending (i.e., at the PA0 rising edge) and, when initially switching the timer from PWM Mode at the end of V-ZC, the software sets the TMR0 reload value to half the duration of the last measured current zero crossing time.

As a result, the hardware automatically generates the start of the SCR pulse at the approximate location of the current zero crossing without software intervention. In the first TMR0 reload interrupt that occurs after PA0 goes Low, the software reconfigures the reload value to correspond to the maximum SCR pulse width (typically 2ms). If there is a second reload interrupt during a zero crossing, the software manually deactivates the SCR pulse but leaves TMR2 active so that an accurate measurement of the current zero crossing duration can be determined on the TMR0 deassertion interrupt that occurs at the end of the zero crossing interval. This deactivation is manifested by summing the TMR0 reload intervals that occur while PA0 is Low, then adding the residual timer count on deassertion. Consequently, shortly after the PA0 rising edge occurs, software reprograms TMR0 to automatically initiate the next SCR pulse.

Note: If there is no PA0 falling edge (i.e., no current zero crossing), an SCR pulse will not get generated. Similarly, if the generated SCR pulse is too far away from the actual midpoint of the current zero crossing, the SCR will stop conducting, the switch will turn off, and no more PA0 falling edges will occur. After approximately 40ms without any PA0 edges, the software determines that the I-ZC-TO event has occurred, and transitions to the OFF state.

While in the ON state, the software must also monitor the load current to ensure that it is within an acceptable range. The external overcurrent circuit pulses PD1 during the portion of the AC signal where the load current is above the maximum threshold (Max). The software configures PD1 as a rising edge interrupt source but does not actually install a sepa-

rate interrupt handler to monitor the overload signal. Because the CPU is brought out of Halt Mode in the ON state (due to an I-Edge or a TMR1 interrupt), the software can poll the state of the PD1 interrupt request signal in the Z8F2480 MCU's interrupt controller to determine if there were any overcurrent events. This configuration helps simplify the software structure and allows greater priority to the I-Edge event. After eight consecutive overcurrent events occur, the software determines that an I>Max event has occurred, and will transition to the OFF state. This transition typically occurs in approximately 80ms.

The software uses two strategies for detecting I<Min. The first strategy is employed within the IZC_Isr after PA0 goes High, thereby ending the load current zero crossing. At this time, the voltage on PB2 (i.e., the load current sense resistor) is above the hardware threshold of approximately 200mV (indicating that the load current is above 200mA) but might not be above the software threshold (default of 220mV). Therefore, at the end of the current zero crossing, IZC_Isr samples the voltage on PB2 (via the ADC) for up to 1ms. If the load current remains below Min for this duration, the second load current sampling strategy is enabled; otherwise, the secondary sampling algorithm is disabled.

If the IZC_Isr is not able to detect I>Min within approximately 1ms of PA0 going High, then the foreground task will monitor the load current while PA0 is High. If no ADC readings above Min are obtained in four consecutive AC half-cycles (approximately 40ms), the software determines that the I<Min event has occurred, and will transition to the OFF state.

While in the ON state, the software continues to monitor the motion detect signal each time the MCU comes out of Halt Mode (which can occur every AC half-cycle). If the motion detect signal is still active, the 30-second motion detect time-out period is reset. If the motion detect signal remains inactive for 30 seconds, the motion detect time-out event occurs (i.e., Mot_TO), causing the Power Switch to be deactivated (i.e., TMR0 is disabled, thereby stopping the SCR pulses), thereby causing the system to transition to the OFF state.

Software Strategy

The current sensing power switch software is designed to minimize the number of time-critical events that must be processed by software. Where possible, hardware timers are used to initiate SCR pulses and time their duration, while software performs the less time-critical operation of calculating the starting position of the next SCR pulse.

The most time-critical event that must be processed by software is servicing the I-Edge interrupt. Within this interrupt service routine, software must quickly calculate the period from the PA0 falling edge until I-ZC for the current zero crossing that just ended and reprogram TMR0 with a new reload value before the next falling edge of PA0, thereby marking the beginning of the next current zero crossing.

For small load currents, PA0 will be Low most of the time, and the next zero crossing occurs approximately ¼ AC period (typically more than 4ms) from the falling edge of PA0. In this instance, after the SCR pulse is initiated by the hardware, the software reprograms the TMR0 reload value with the maximum SCR pulse width (typically 2ms). Therefore, when PA0 goes High, thereby ending the current zero crossing interval, the

software has almost 2ms to modify the TMR0 reload value to enable the hardware to start the next SCR pulse ¼ period from the PA0 falling edge.

For large load currents, PA0 will be High most of the time, and the current zero crossing occurs shortly after the falling edge of PA0. In this instance, the software programs the TMR0 Reload Register with a nominal value corresponding to 100µs. As long as the actual zero crossing is larger than 200µs, the software will have sufficient time to keep the SCR pulse active for up to 2ms, and will not be required to modify the TMR0 reload interval.

This strategy requires the software to start processing the I-Edge (TMR0) interrupt as soon as possible to maintain low interrupt latency. If other interrupts are active when TMR0 interrupts occur, the software may not have sufficient time to reposition the SCR pulse before the next load current zero crossing. To minimize I-Edge interrupt latency, other interrupt handlers are either disabled (e.g., V-Edge) and use extremely short interrupt service routines (e.g., the TMR1 interrupt handler only increments an 8-bit counter) or the interrupt task is delayed until time-critical tasks complete (e.g., the overcurrent signals on PD1 are latched in the hardware but not processed until it is known that software has completed I-Edge processing).

Software Events

Table 2 summarizes the main events that cause software state transitions.

Table 2. Main Events that Cause Software State Transitions

Event	Z8F6482 Signal	Meaning/Usage
V-Edge	PD3–C1 Out	The comparator output is a half-wave rectified representation of the mains voltage. During Voltage Zero Crossing (V-ZC) detection, the software measures the time between 3 edges to estimate the AC period and position of V-ZC. After estimating V-ZC, the software activates the first SCR pulse to turn on the Power Switch. V-Edge is a dual-edge interrupt in the V-ZC state.
I-Edge	PA0, PB0 Op-Amp Out TMR0 reload and deassertion	The Op-Amp compares the (full-wave rectified) voltage drop across a current sense resistor to a nominal 200mV reference and generates on open-loop signal on PB0 that is externally connected to PA0 to allow edge-triggered interrupts and/or provide a enable signal for TMR0. The software uses I-Edge to measure the time that PA0 is Low to estimate when the next SCR pulse must be generated in the ON state.
I > Max	PD1	If the load current exceeds approximately 3A, the external circuitry drives PD1 High. PD1 is configured as a rising edge interrupt source (however, the interrupt remains disabled), allowing an overload condition to be latched in the Z8F2480 MCU's interrupt controller between periods in which the software samples the pin. PD1 is sampled approximately every half-cycle (i.e., at 2x the AC frequency). After 8 consecutive overload events, the software determines I > Max.

Table 2. Main Events that Cause Software State Transitions (Continued)

Event	Z8F6482 Signal	Meaning/Usage
I < Min	PB2	The voltage on PB2 is sampled around the expected peak current (i.e., the midpoint between load current zero crossings) approximately every half-cycle. If all samples in 4 consecutive sampling windows are below a configurable threshold, the software determines I < Min.
I–OK	PD1 and PB2	When the Power Switch is in the ON state, the software determines I-OK if the load current remains above Min and below Max.
V-ZC-TO I-ZC-TO	TMR2	While in the V-ZC or ON states, TMR2 is configured to generate a one-shot time-out of approximately 40ms to allow sufficient time to estimate the period of the AC signal from three V-Edge events in V-ZC. When the period calculation completes, TMR2 is reset for another 40ms. During I-ZC, TMR2 is reset each time PA0 goes High. If TMR2 stops, the software determines that either a V-ZC or I-ZC time-out has occurred. In this instance, the software increments a retry counter. This retry counter is reset approximately 10 AC half-cycles after entering the ON state.
Retry > Max		Each time a V-ZC or I-ZC time-out event occurs, the software increments a retry counter. In V-ZC, if the retry counter is less than Max, V-ZC is restarted; otherwise, the system transitions to the OFF state. In I-ZC, an I-ZC time-out event causes a transition to the OFF state (i.e., Max=0 during I-ZC).
Motion		Refers to the nMOTION_DET signal generated by the ZMOTION MCU controller, which asserts this signal when motion is detected, thereby causing the software to transition to the V-ZC state from the OFF state, or to stay within the ON state. Each time the motion detect signal is active, a 30-second no-motion timer is reset.
Mot_TO		If the nMOTION_DET signal from the ZMOTION MCU remains inactive for at least 30 seconds while the software is in the ON state, the system is transitioned to the OFF state.

Setup, Configuration, and Use

This section describes how to set up, configure, and operate the Power Switch with ZMOTION Control.

Warning: The Base Power Board is electrically connected to AC power and contains points with high voltage (up to 400 V). If any measurements will be performed on the Base Power Board, a power supply with an isolation transformer should be used to avoid electrical shock. Persons working with this Base Power Board should be fully qualified to work with high-voltage devices.

Powering the Board

The Base Power Board should be powered from a single-phase AC source between 90 to 240 V RMS. If any measurements will be performed on this Board, an insulated power source should be used to avoid the hazards of electrical shock and board damage.

The Board should be connected to an American standard AC wall receptacle. Loads should be connected to the Board using an American standard three-pronged plug, which is inserted into the on-board receptacle.

The Board wakes up and turns on the load after a delay of approximately one second.

Downloading and Installing ZDSII

Note: If you have already installed ZDSII – Z8 Encore! <version> and have downloaded the RD0023-SC01 software and documentation by following the procedure on the paper insert in your kit (FL0159), skip ahead to the Viewing and Rebuilding ZMOTION Detection Module II Software section on page 15.

The Current Sensing Power Switch SCR with ZMOTION Control Reference Design is delivered with the software installed and ready to use. If modifications are made to the existing software, it is necessary to use the ZDSII – Z8 Encore! Integrated Development Environment to update the firmware image stored in Z8F2480 MCU Flash memory.

Observe the following procedure to download and install ZDSII.

1. Download the latest version of ZDSII – Z8 Encore! from the Downloadable Software category in the Zilog Store.
2. Run the software installation file and follow the on-screen instructions to install ZDSII – Z8 Encore!.

Downloading and Installing the Software

Observe the following brief procedure to download and install your RD0023-SC01 software.

1. In the Zilog Store, under Categories, click **Downloadable Software** to present a list of the available software in the Zilog Store. In this list, click **ZMOTION Software and Documentation**; the Product ID for this software is SD00025. On the Product Details page that appears next, click the blue **Add to Cart** button and complete the checkout process to download the ZMOTION software and documentation files to your hard drive.
2. Download the RD0023-SC01 software files, which are available free from the Zilog website.
3. When the download is complete, unzip the file to a convenient location on your PC's hard drive. Double-click the following installation file and follow the on-screen instructions:

ZRD0023SCZMZRD_<version>.exe

Viewing and Rebuilding the Base Power Board Software

Note: Source code and ZDSII project files are provided with this reference design to allow users to become familiar with the operation of the AC Power Switch. No software modifications are required to use this reference design.

Observe the following procedure to view and rebuild the Base Power Board software.

1. Launch the ZDSII – Z8 Encore! application by navigating via the Windows Start menu to:

   Programs → Zilog ZDSII_Z8Encore!_<version_number> → ZDSII_Z8Encore!<version_number>

2. From the **File** menu, select **Open Project**. The Open dialog box appears.
3. Browse to the ZRD0023SCZMZRD Base Power Board which, by default, is located in the following path:

   C:\Program Files\Zilog\ZRD0023SCZMZRD_<version>\Firmware\Base Board\

4. Select the AC_Switch_ZM.zdsproj file and click **Open** to display the initial ZDSII program screen. To view the source files, double-click the Project Files folder on the left side of the IDE interface. Double-click an individual file to open the file in the ZDSII file editor.
5. Click the **Rebuild All** toolbar icon or select the **Build → Rebuild All** menu option.
6. When the rebuild is complete, a Build succeeded message will appear, as highlighted in Figure 6.

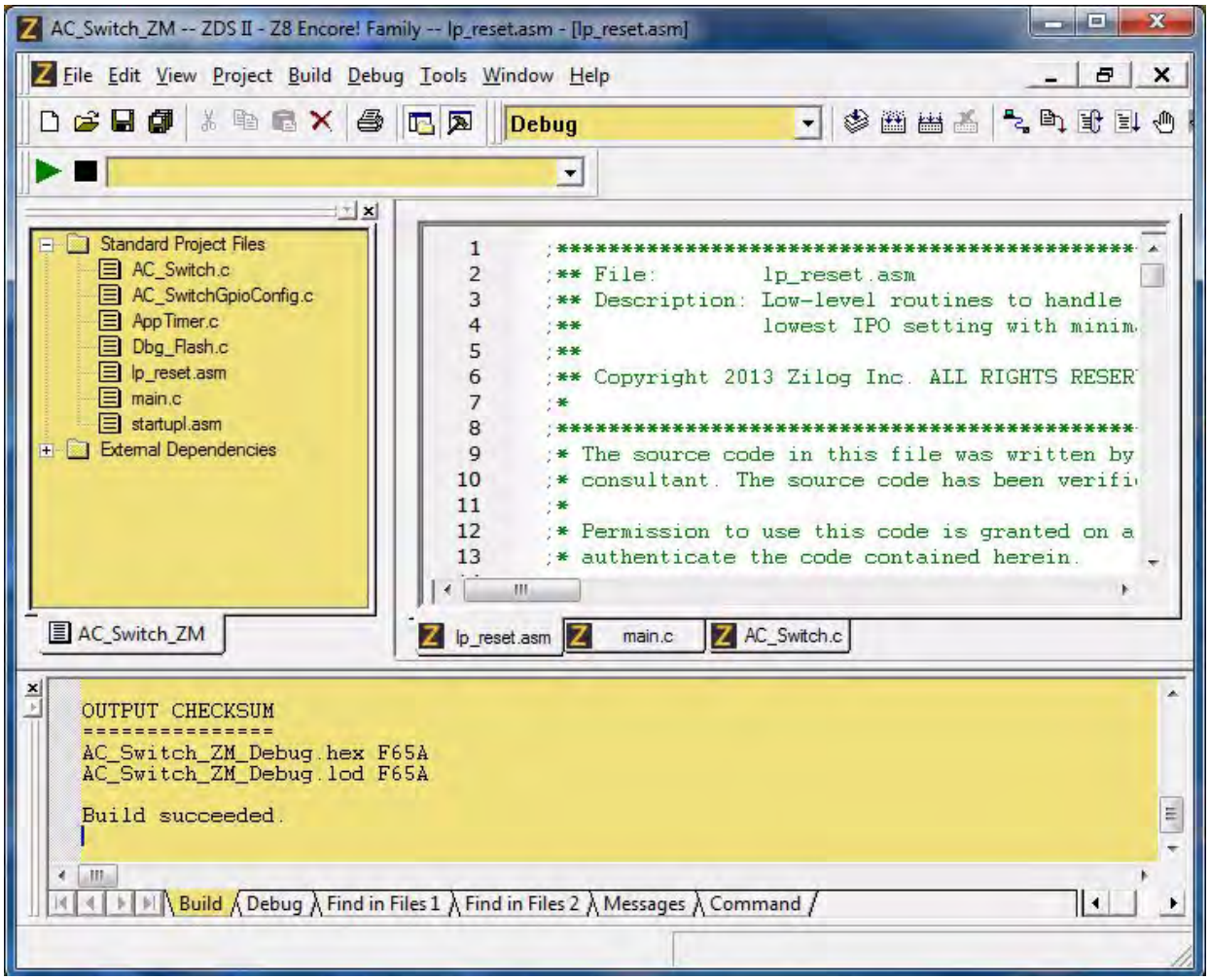


Figure 6. A Successful Build

Note: The checksum shown in Figure 6 may be different at the time of the software release.

Viewing and Rebuilding ZMOTION Detection Module II Software

Note: Source code and ZDS II project files are provided with this reference design to allow users to become familiar with the operation of the AC Power Switch. No software modifications are required to use this reference design.

Observe the following procedure to view and rebuild the ZMOTION Detection Module II software.

1. From the **File** menu, select **Open Project**. The Open dialog box appears.
2. Browse to the ZMOTION Detection Module II project which, by default, is located in the following path:

   `C:\Program Files\Zilog\ZRD0023SCZMZRD_<version>\Firmware\ZMOTION\`

3. Select the `ZMOTION.zdsproj` file and click **Open** to display the initial ZDSII program screen. To view the source files, double-click the **Project Files** folder on the left side of the IDE interface. Double-click an individual file to open the file in the ZDSII file editor.
4. Click the **Rebuild All** toolbar icon or select the **Build → Rebuild All** menu option.
5. When the rebuild is complete, a `Build succeeded` message will appear, as highlighted in Figure 7.

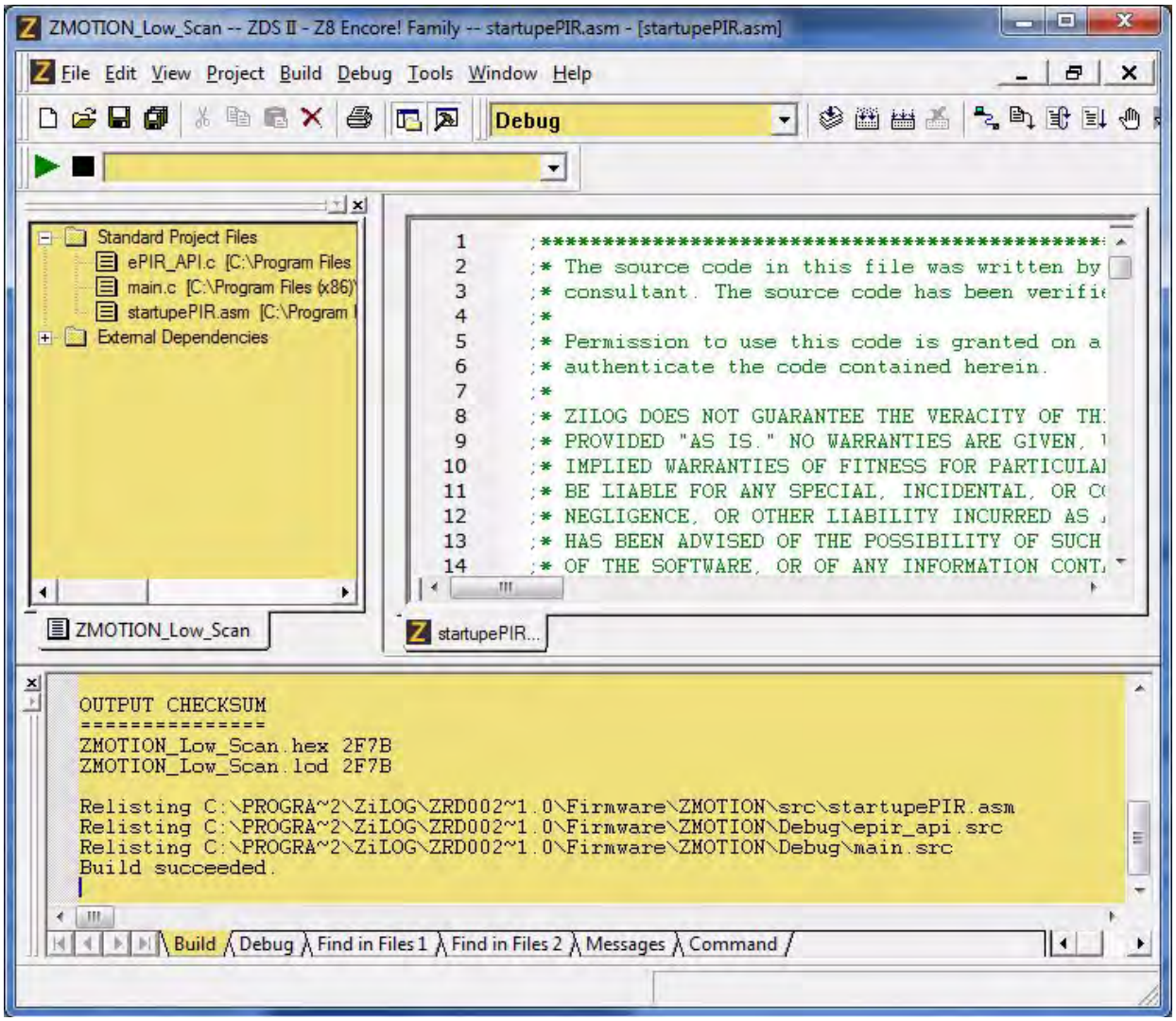


Figure 7. A Successful Build

Note: The checksum shown in Figure 7 may be different in the final software release.

Electrical Specifications

This section describes the electrical characteristics of the Current Sensing Power Switch SCR with ZMOTION Control Reference Design Board and reflects all available data as a result of testing prior to qualification and characterization. As such, the data presented in this document is subject to change.

Absolute Maximum Ratings

Table 3 lists the absolute maximum stress ratings of the Current Sensing Power Switch SCR with ZMOTION Control Reference Design Board.

Table 3. Absolute Maximum Ratings

Parameter	Rating	Unit
AC operating voltage RMS maximum	240	V
AC Blocking Voltage	600	V
Load Current, RMS	3	A
Storage Temperature Range	–65 to +160	°C
Operating Temperature Range	–40 to +65	°C

Stresses greater than those listed in Table 3 may cause permanent damage to the device. These ratings are stress ratings only. Operation of the device at any condition outside those indicated in the operational sections of these specifications is not implied. Exposure to absolute maximum rating conditions for extended periods affects device reliability.

Recommended Operating Conditions

Table 4 lists the recommended operating conditions of the Current Sensing Power Switch SCR with ZMOTION Control Reference Design Board.

Table 4. Recommended Operating Conditions

Parameter	Rating	Unit
AC voltage RMS range	90–230	V
Ambient Temperature Range	–20 to +45	°C

Electrical Operating Characteristics

Table 5 lists electrical operating characteristics of the Current Sensing Power Switch SCR with ZMOTION Control Reference Design Board.

Table 5. Electrical Operating Characteristics

Name	Conditions	Min	Typ	Max	Units
Power Board load current	240 V RMS			3	A
Standby Mode input current (switch is off)	120 V RMS		2		mA
Overcurrent protection threshold	8 consecutive half waves			4	A
Minimum load current			220		mA

Figures 8 and 9 show waveforms for the operation of the Base Power Board.

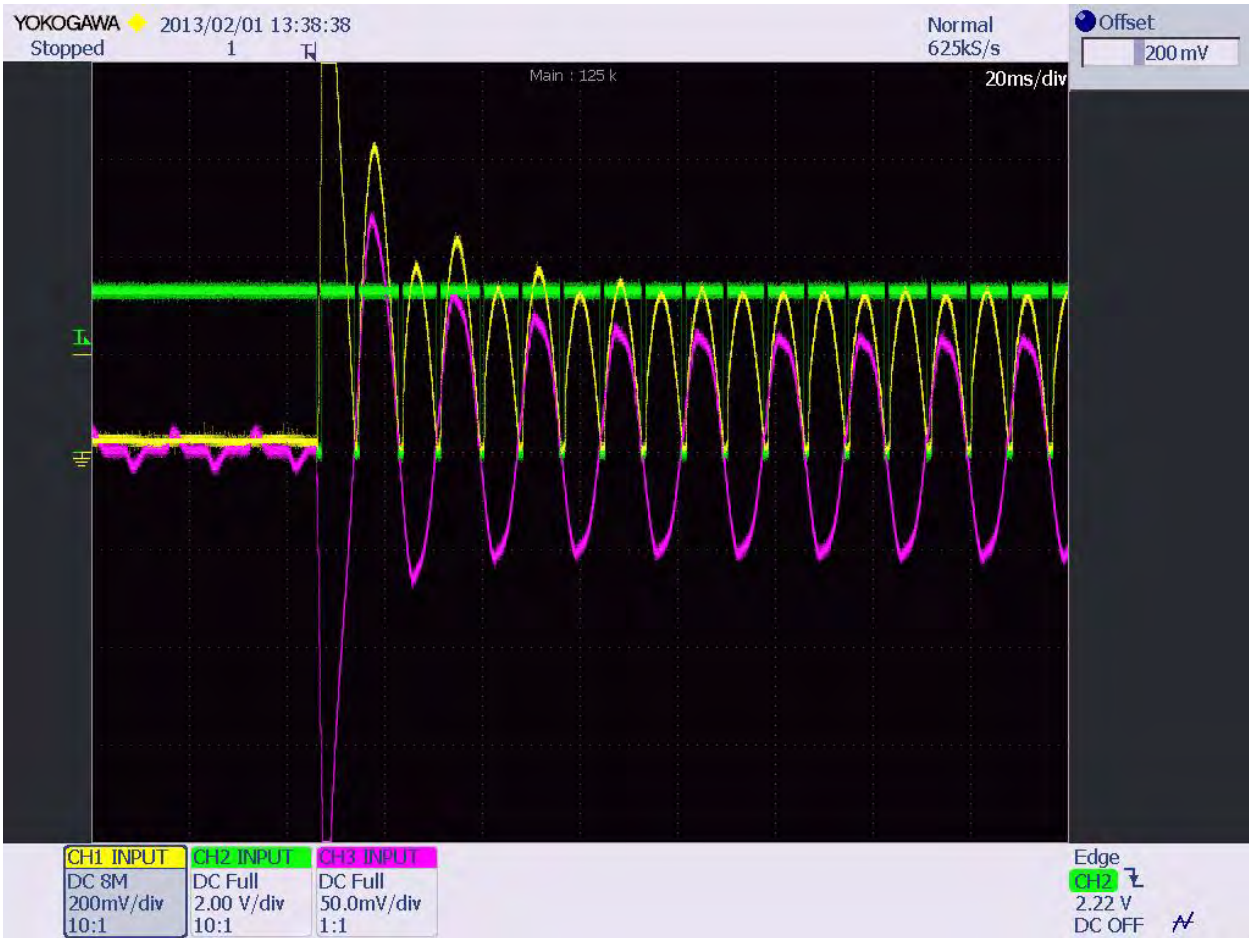


Figure 8. Switcher Executes Command ON

The three channels in Figure 8 are described below.

Yellow. Channel 1: Rectified load current.

Green. Channel 2: Pulses to turn CPC1966 ON.

Red. Channel 3: Load current.

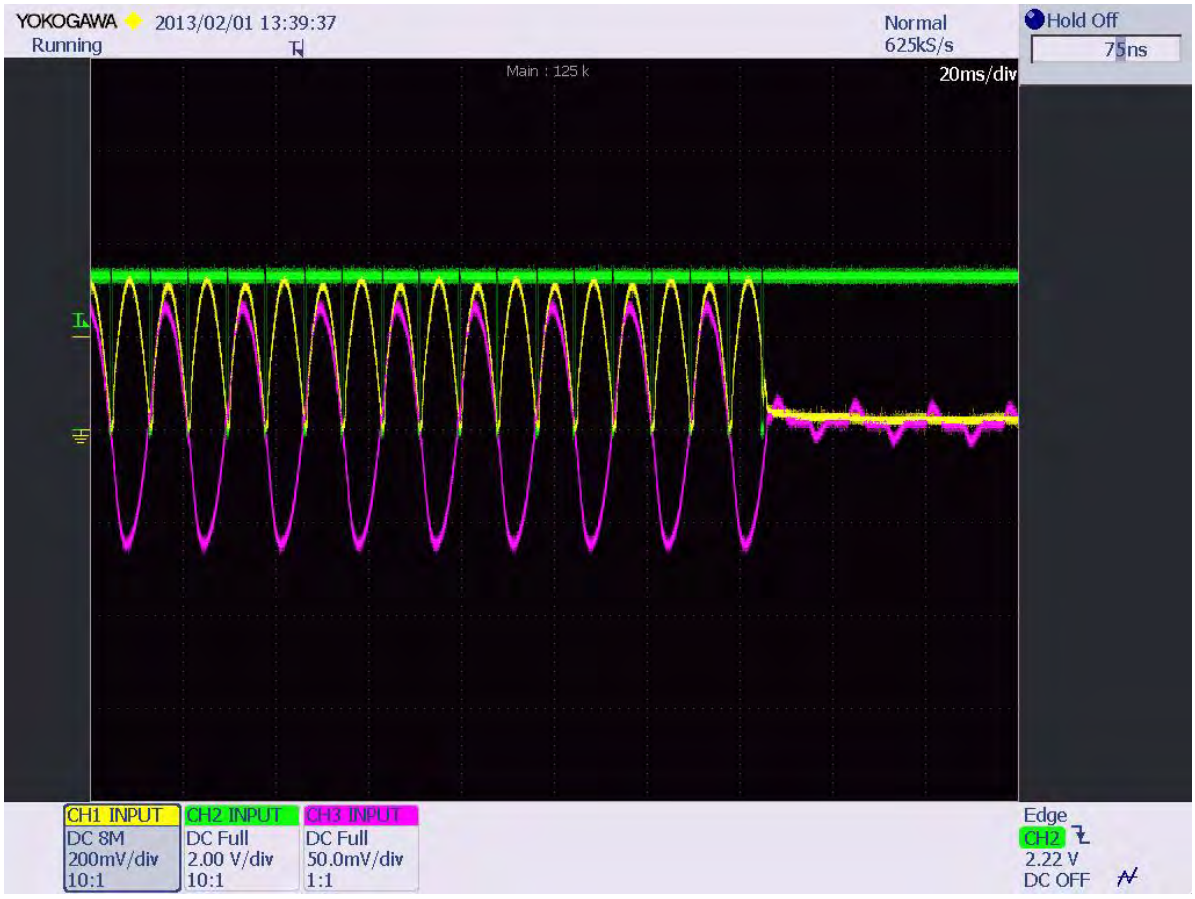


Figure 9. Switcher Executes Command OFF

The three channels in Figure 9 are described below.

Yellow. Channel 1: Rectified load current.

Green. Channel 2: Pulses to turn CPC1966 ON.

Red. Channel 3: Load current.

Ordering Information

The products associated with this Current Sensing Power Switch SCR with ZMOTION Control Reference Design can be purchased from the Zilog Store – simply click the Store Product ID listed in Table 6.

Table 6. Current Sensing Power Switch Reference Design: Ordering Information

Part Number	Description	Store Product ID
ZRD0023SCZMZRD	Current Sensing Power Switch SCR with ZMOTION Control Reference Design	RD10034

Kit Contents

The Current Sensing Power Switch SCR with ZMOTION Control Reference Design contains the following items:

- Base Power Board (preprogrammed with software contained in the RD0023-SC01 source code file)
- ZMOTION Detection Module II (affixed to the Base Power Board)
- Current Sensing Power Switch SCR with ZMOTION Control Reference Design Kit Insert (FL0159)

Software and Documentation

Upon installation, the software and documentation for this reference design will be located in the following directories.

```
<Installation directory>
   \Docs
   \Firmware
      |___ Base Board
      |___ ZMOTION
   \PCB
```

Related Documentation

The documents associated with this Current Sensing Power Switch SCR with ZMOTION Control Reference Design are listed in Table 7. Each of these documents can be obtained from the Zilog website by clicking the link associated with its document number.

Table 7. ZMOTION RF Wireless Module Documentation

Document Number	Description
RD0023	This Current Sensing Power Switch SCR with ZMOTION Control Reference Design document.
RD0023-SC01	Source code for the Current Sensing Power Switch SCR with ZMOTION Control Reference Design
PS0305	ZMOTION Detection Module II Product Specification
UM0260	ZMOTION Detection Module II Evaluation Kit User Manual
RD0026	ZMOTION Detection Module II Reference Design

Appendix A. Schematic Diagrams

Figure 10 presents a schematic diagram of the Base Power Board.

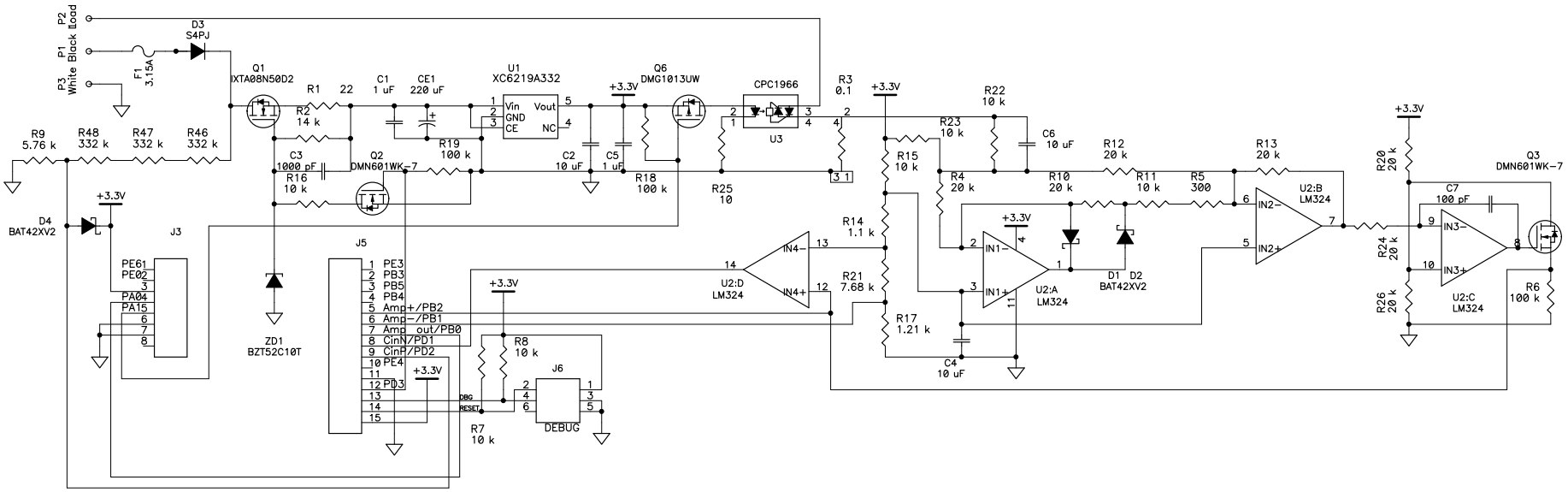
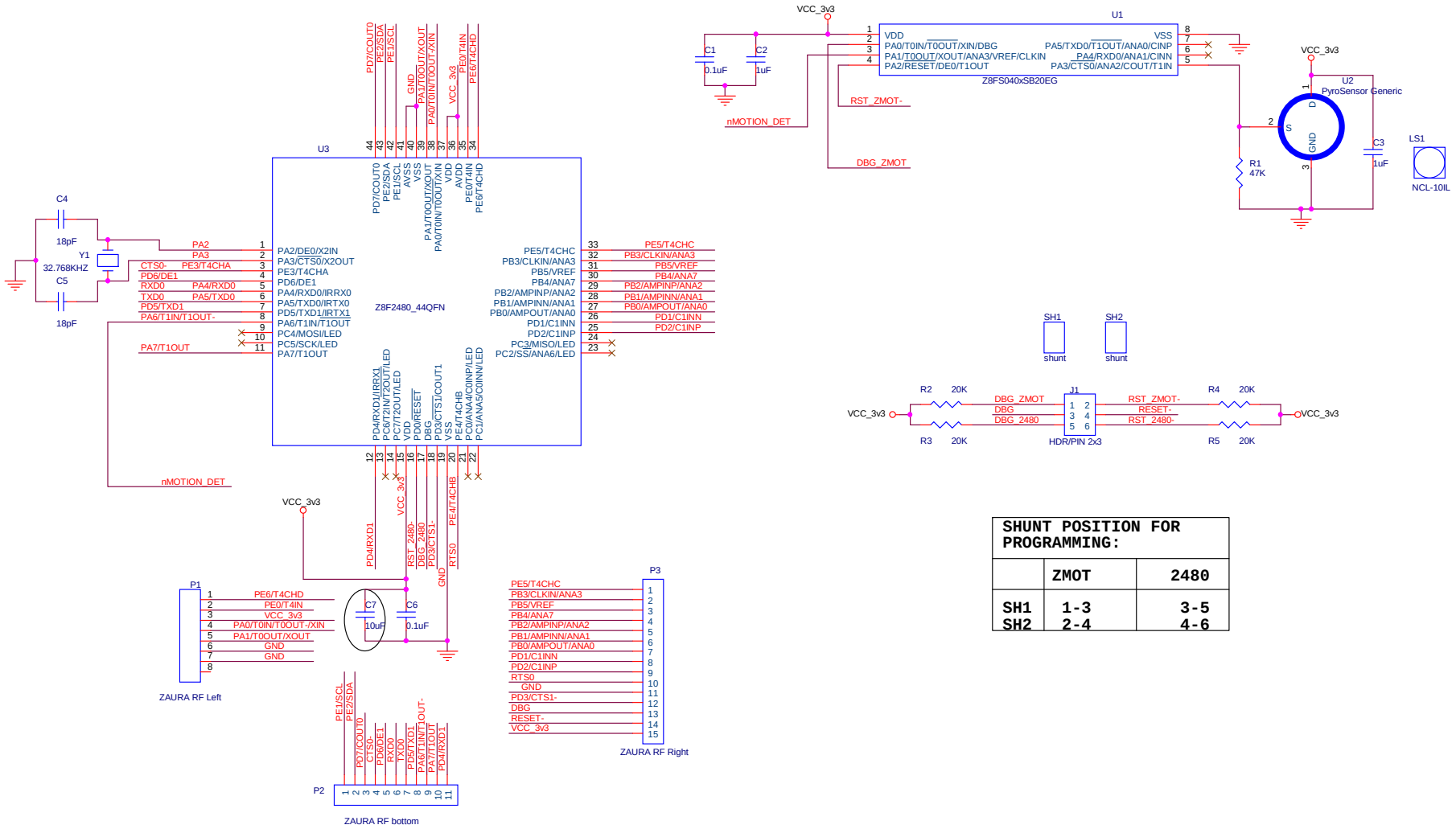


Figure 10. Schematic Diagram of the Base Power Board

Figure 11 presents a schematic diagram of the ZMOTION Detection Module II.



SHUNT POSITION FOR PROGRAMMING:		
	ZMOT	2480
SH1	1-3	3-5
SH2	2-4	4-6

Figure 11. Schematic Diagram of the ZMOTION Detection Module II

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