

Magnetic Replacement Ballast IC

Features

- Ballast control plus half-bridge driver in one IC
- Single-stage topology (no PFC stage required)
- High PF and low THD
- Preheat, ignition and running lamp modes
- Closed-loop lamp current control
- Half-bridge NZVS protection
- Adaptive dead-time
- Lamp insert auto-restart
- Internal bootstrap MOSFET
- Micro-power start-up current
- 15.6V internal zener clamp on VCC
- Excellent ESD and latch immunity
- RoHS compliant
- 8-pin SO8 package

Applications

- Magnetic replacement electronic ballast
- Low cost electronic ballast

Description

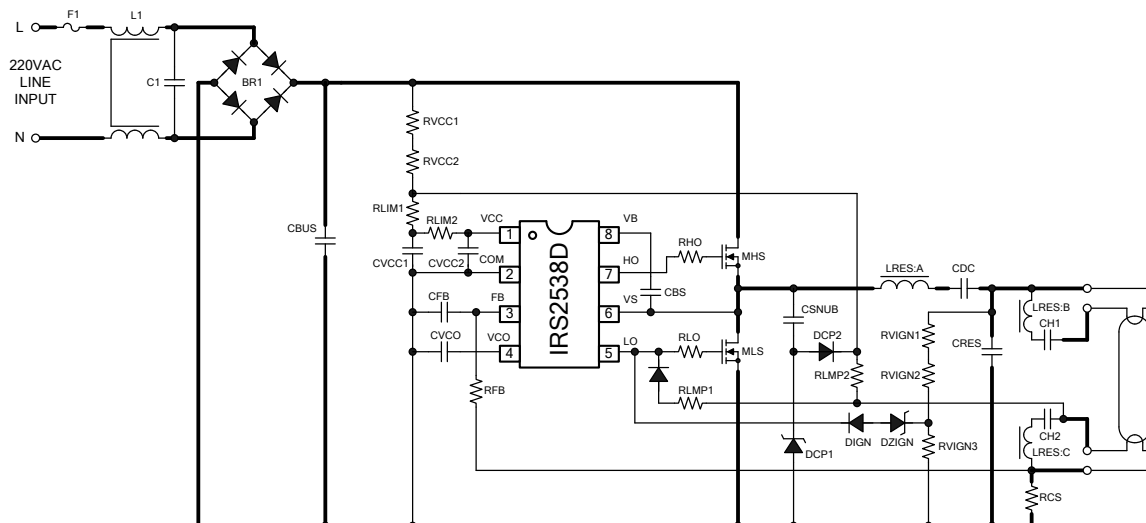
This IC takes full advantage of IR's patented ballast and high-voltage technologies to realize a simple, high-performance magnetic ballast replacement solution. The IC includes a novel single-stage circuit topology and control method to achieve high power factor and low THD without a PFC stage or any electrolytic capacitors. A single high-voltage pin senses the half-bridge voltage to perform necessary protection functions. Closed-loop control of the lamp current provides constant lamp brightness over a wide line input voltage range. Combining these high-voltage control algorithms in a single 8-pin IC results in a large reduction in component count, an increase in manufacturability and reliability, a reduced design cycle time, while maintaining high ballast system performance.

Package Options



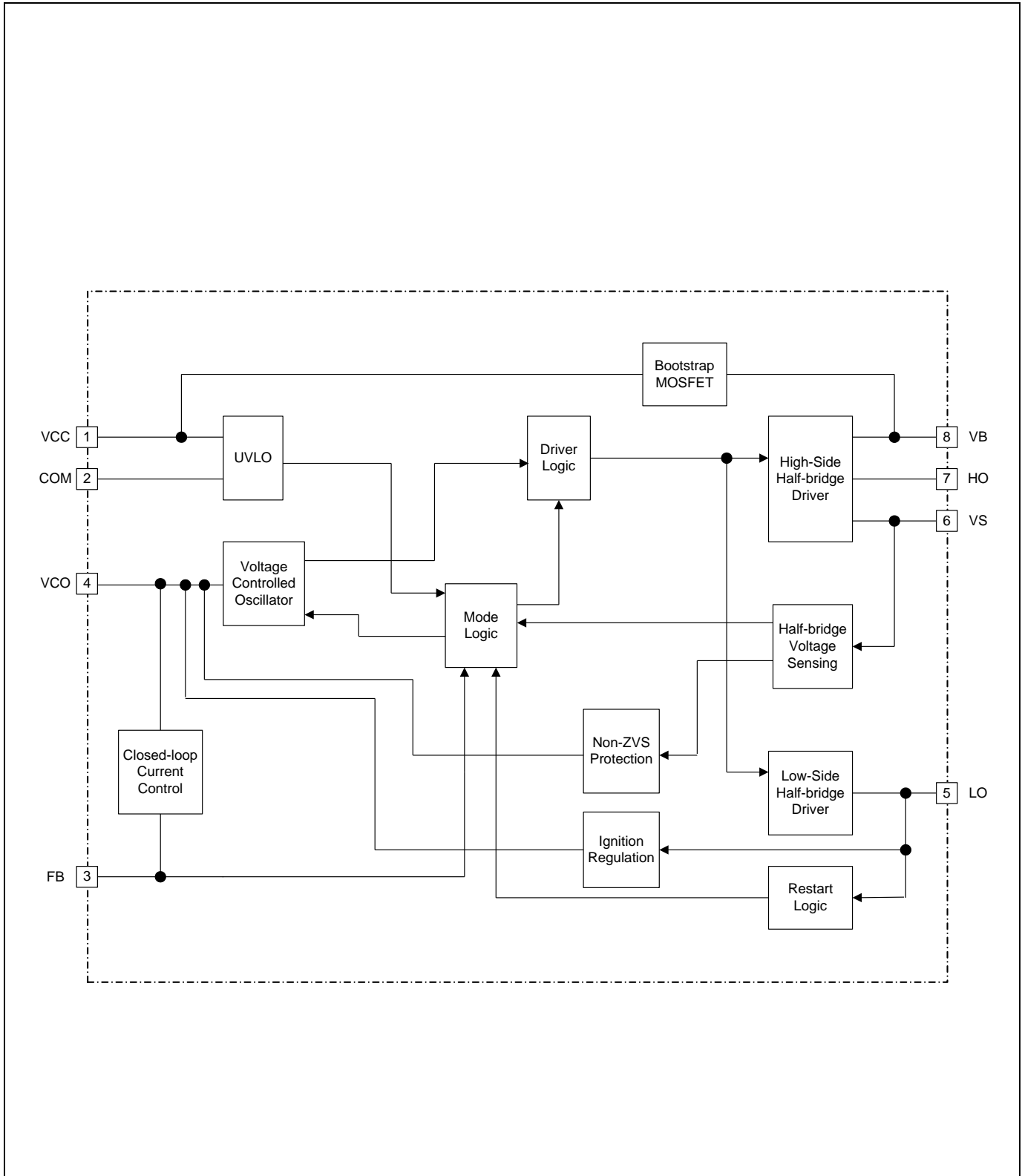
8-Lead SOIC

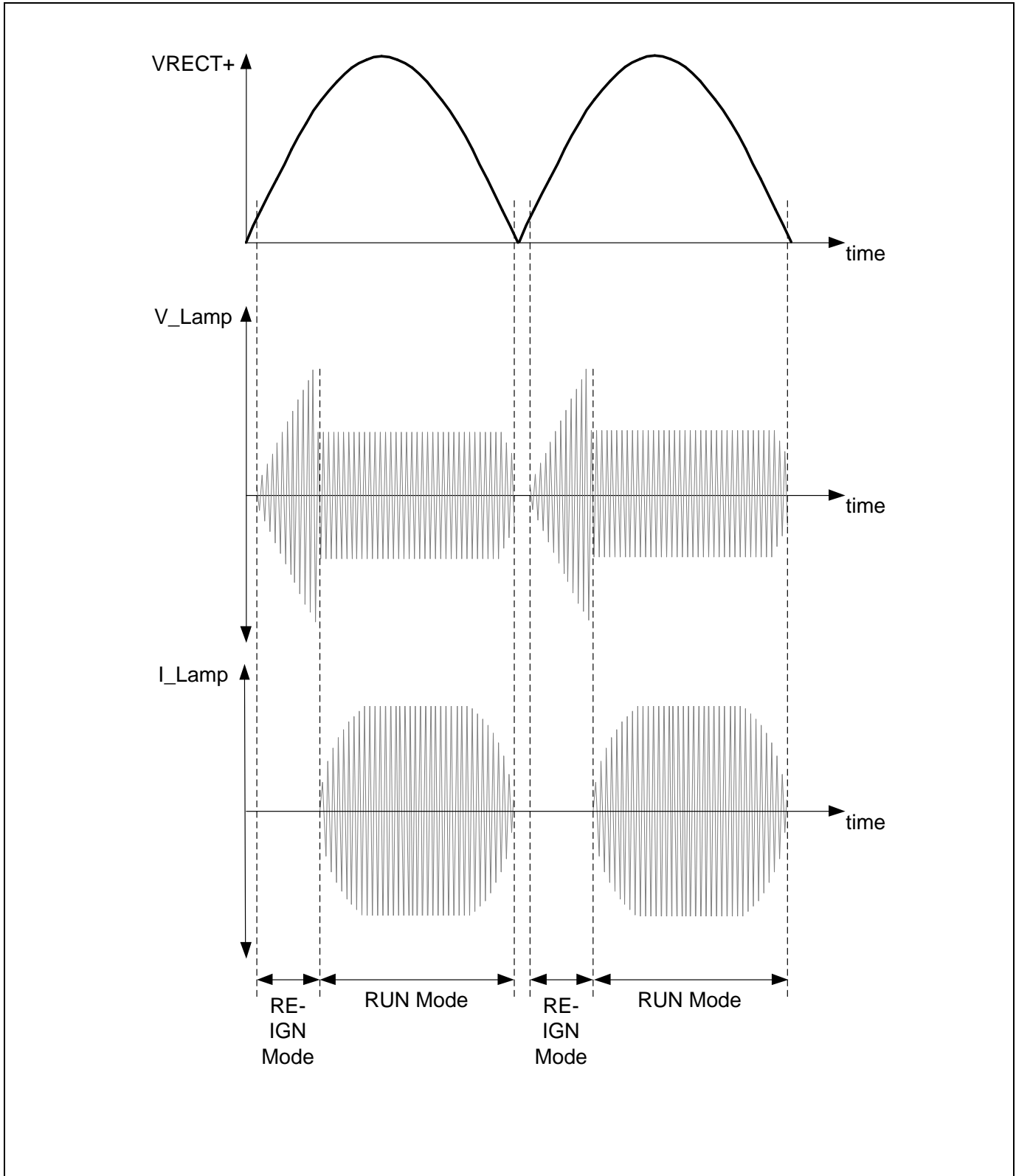
Application Diagram



Ordering Information

| Base Part Number | Package Type | Standard Pack | | Orderable Part Number |
|------------------|--------------|---------------|----------|-----------------------|
| | | Form | Quantity | |
| IRS2538DSPBF | SO8N | Tape and Reel | 2500 | IRS2538DSTRPBF |

Functional Block Diagram


Timing Diagram

Qualification Information[†]

| | | | |
|-----------------------------------|------------------|---|---|
| Qualification Level | | Industrial ^{††} (per JEDEC JESD 47E) | |
| | | Comments: This family of ICs has passed JEDEC's Industrial qualification. IR's Consumer qualification level is granted by extension of the higher Industrial level. | |
| Moisture Sensitivity Level | | SOIC8N | MSL2 ^{†††} (per IPC/JEDEC J-STD-020C) |
| ESD | Machine Model | Class A (per JEDEC standard EIA/JESD22-A115-A) | |
| | Human Body Model | Class IC (per EIA/JEDEC standard JESD22-A114-B) | |
| IC Latch-Up Test | | Class I, Level A (per JESD78A) | |
| RoHS Compliant | | Yes | |

† Qualification standards can be found at International Rectifier's web site <http://www.irf.com/>

†† Higher qualification ratings may be available should the user have such requirements. Please contact your International Rectifier sales representative for further information.

††† Higher MSL ratings may be available for the specific package types listed here. Please contact your International Rectifier sales representative for further information.

Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to COM, all currents are defined positive into any pin. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions.

| Symbol | Definition | Min. | Max. | Units |
|--------------------------|---|----------|-----------|-------|
| VB | High-Side Floating Supply Voltage | -0.3 | 625 | V |
| VS | High-Side Floating Supply Offset Voltage | VB - 25 | VB + 0.3 | |
| VHO | High-Side Floating Output Voltage | VS - 0.3 | VB + 0.3 | |
| VLO | Low-Side Output Voltage | -0.3 | VCC + 0.3 | |
| VVCO | VCO Input Voltage | -0.3 | 6 | |
| VFB | FB Input Voltage | -0.3 | VCC + 0.3 | |
| ICC | Supply Current [†] | --- | 20 | mA |
| IO_{MAX} | Maximum allowable current at LO, HO and PFC due to external power transistor Miller effect. | -500 | 500 | |
| dV_S/dt | Allowable VS Pin Voltage Slew Rate | -50 | 50 | V/ns |
| PD | Maximum Power Dissipation @ T _A ≤ +25°C, 8-Pin SOIC | --- | 0.625 | W |
| R_{θJA} | Thermal Resistance, Junction to Ambient, 8-Pin SOIC | --- | 128 | °C/W |
| T_J | Junction Temperature | -55 | 150 | °C |
| T_S | Storage Temperature | -55 | 150 | |
| T_L | Lead Temperature (Soldering, 10 seconds) | --- | 300 | |

†: This IC contains a voltage clamp structure between the chip VCC and COM which has a nominal breakdown voltage of 15.6V. This supply pin should not be driven by a DC, low impedance power source greater than the VCLAMP specified in the Electrical Characteristics section.

Recommended Operating Conditions

For proper operation the device should be used within the recommended conditions.

| Symbol | Definition | Min. | Max. | Units |
|------------|---|--------------------|--------|-------|
| VBS | High-Side Floating Supply Voltage | VCC - 0.7 | VCLAMP | V |
| VS | Steady State High-Side Floating Supply Offset Voltage | -3.0 ^{††} | 600 | V |
| VCC | Supply Voltage | VCCUV+ + 0.1V | VCLAMP | V |
| ICC | Supply Current | ††† | 5 | mA |
| TJ | Junction Temperature | -40 | 125 | °C |

††: Care should be taken to avoid output switching conditions where the VS node rings below COM by more than 5V.

†††: Enough current should be supplied to the VCC pin of the IC to keep the internal 15.6V zener diode regulating at its voltage, VCLAMP.

Electrical Characteristics

V_{CC}=V_{BS}=14V, V_S=0V and T_A = 25°C unless otherwise specified. The output voltage and current (V_O and I_O) parameters are referenced to COM and are applicable to the respective HO and LO output pins.

| Symbol | Definition | Min | Typ | Max | Units | Test Conditions |
|---|--|------|------|------|-------|---|
| Low Voltage Supply Characteristics | | | | | | |
| V _{CLAMP} | V _{CC} Zener Clamp Voltage | 14.5 | 15.5 | 16.5 | V | I _{CC} = 10mA |
| V _{CCUV+} | Rising V _{CC} UVLO Threshold | 11.2 | 11.8 | 12.3 | | |
| V _{CCUV-} | Falling V _{CC} UVLO Threshold | 8.5 | 9.0 | 9.5 | | |
| V _{CCUVHYS} | V _{CC} UVLO Hysteresis | --- | 2.8 | --- | | |
| I _{QCCUV} | Micro-power Startup V _{CC} Supply Current | --- | --- | 125 | μA | V _{CC} = V _{CCUV+} - 500mV |
| I _{CCfmin} | f _{MIN} V _{CC} Supply Current | --- | 2.2 | --- | mA | V _{CO} ≥ 5V |
| I _{CCfmax} | f _{MAX} V _{CC} Supply Current | --- | 3.2 | --- | | V _{CO} = 0V |
| I _{QCCFLT} | Fault Mode V _{CC} Supply Current | --- | --- | 300 | μA | MODE = FAULT, V _{CC} = V _{CCUV+} |
| Floating Supply Characteristics | | | | | | |
| I _{QBS} | Quiescent V _{BS} Supply Current | --- | 28 | --- | μA | |
| V _{BSUV+} | Rising V _{BS} Supply UVLO Threshold | --- | 7.2 | --- | V | |
| V _{BSUV-} | Falling V _{BS} Supply UVLO Threshold | --- | 6.8 | --- | | |
| I _{LK} | Offset Supply Leakage Current | --- | --- | 170 | μA | V _B = V _S = 600V |
| Ballast Control Characteristics | | | | | | |
| f _{MIN} | Minimum Output Frequency | 17.4 | 18.3 | 19.4 | kHz | V _{CO} ≥ 5V |
| f _{MAX} | Maximum Output Frequency | 80.9 | 85.6 | 91.3 | | V _{CO} = 0V |
| d | Duty Cycle | --- | 50 | --- | % | |
| DT _{MIN} | Minimum Output Dead-time (HO or LO) | --- | 0.48 | --- | μs | |
| DT _{MAX} | Maximum Output Dead-time (HO or LO) | --- | 1.35 | --- | | |
| V _{LOSD+} | LO Pin Shutdown Threshold | --- | 13.3 | --- | V | MODE = FAULT |
| V _{LOSD-} | LO Pin Re-start Threshold | --- | 11.1 | --- | | |
| V _{LORSTHYS} | LO Pin Restart Hysteresis | --- | 2.2 | --- | | |
| V _{ZVSTH} | V _S Non-ZVS Detection Threshold | --- | 4.6 | --- | | |

Electrical Characteristics

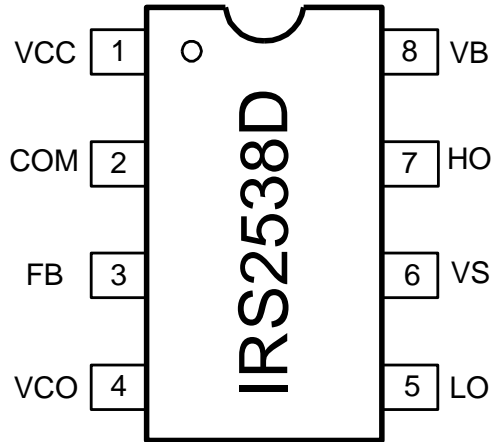
VCC=VBS=14V, VS=0V and TA = 25°C unless otherwise specified. The output voltage and current (VO and IO) parameters are referenced to COM and are applicable to the respective HO and LO output pins.

| Symbol | Definition | Min | Typ | Max | Units | Test Conditions |
|--------------------------------------|-------------------------------------|------|------|------|-------|-------------------------------|
| PREHEAT Mode Characteristics | | | | | | |
| T _{PH} | Preheat Time | --- | 2.0 | --- | sec | f _{Line} = 60Hz, GBD |
| | | --- | 2.4 | --- | | f _{Line} = 50Hz, GBD |
| IGNITION Mode Characteristics | | | | | | |
| V _{LOIGN+} | LO Pin Ignition Voltage Threshold | --- | VCC | --- | V | MODE = RE-IGN |
| RUN Mode Characteristics | | | | | | |
| V _{FBREG+} | FB Pin Regulation Threshold | 0.93 | 1.0 | 1.09 | V | |
| V _{IGNDET+} | FB Pin Ignition Detection Threshold | 0.1 | 0.2 | 0.3 | | |
| VCO Control Characteristics | | | | | | |
| I _{VCO} | VCO Charging Current | 9.8 | 10.8 | 11.7 | uA | MODE = IGN |
| I _{VCO_ZVS} | ZVS VCO Discharging Current | --- | 400 | --- | | |

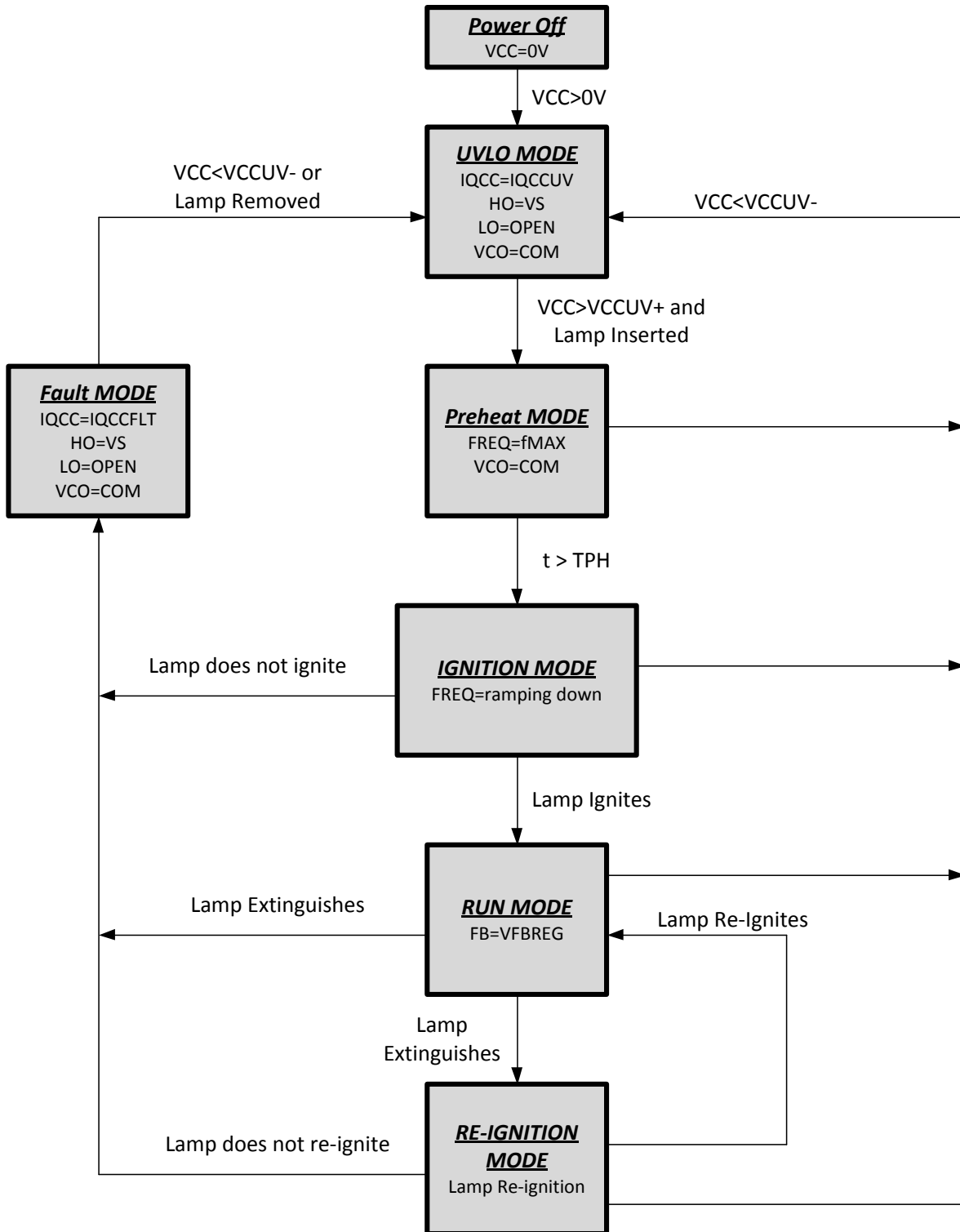
Electrical Characteristics

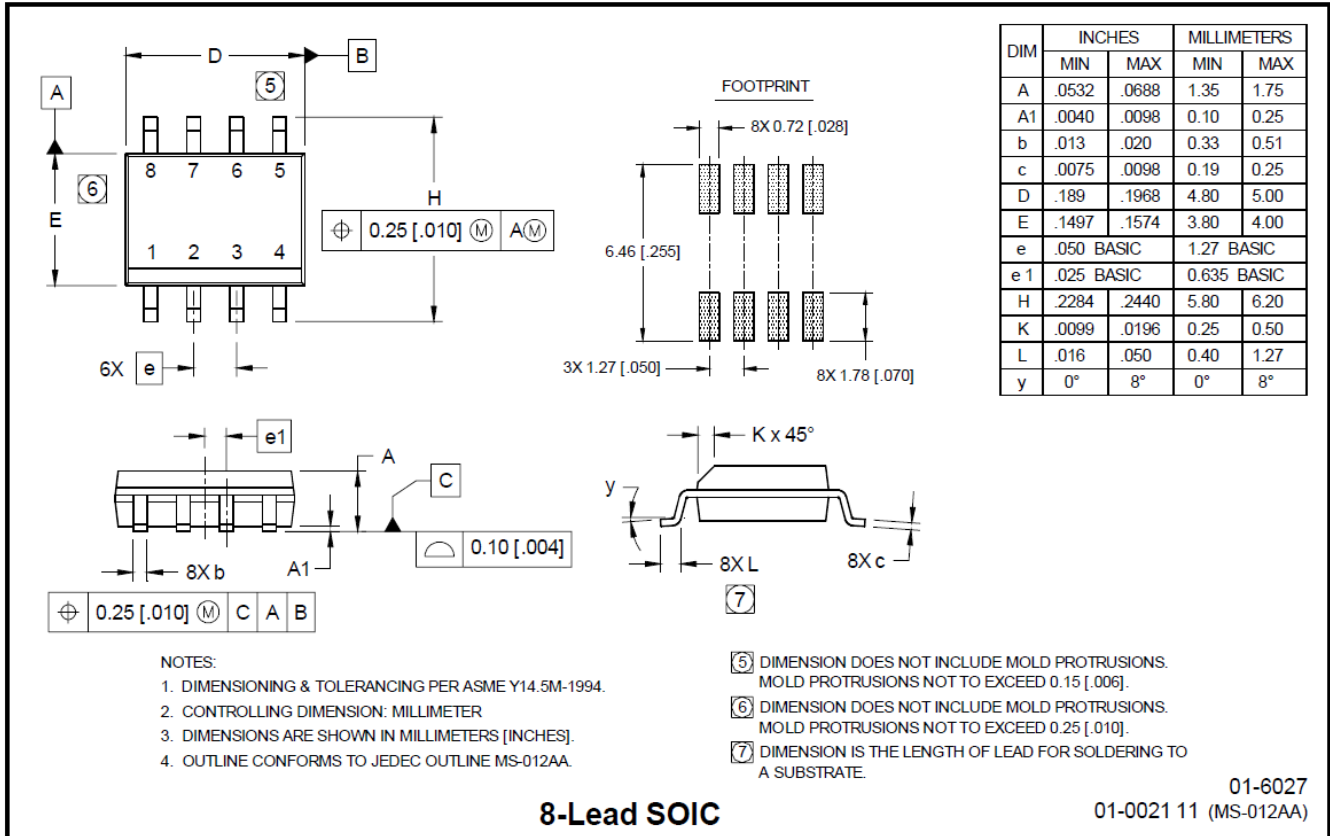
VCC=VBS=14V, VS=0V and TA = 25°C unless otherwise specified. The output voltage and current (VO and IO) parameters are referenced to COM and are applicable to the respective HO and LO output pins.

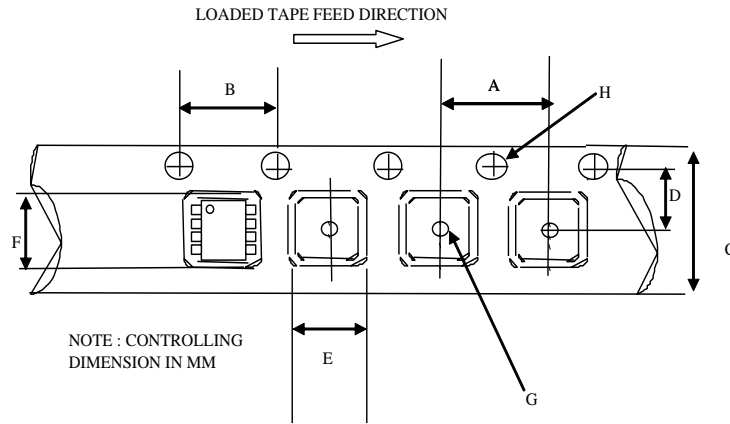
| Symbol | Definition | Min | Typ | Max | Units | Test Conditions |
|---|---|-----|------|-----|-------|---|
| Gate Driver Output Characteristics (HO and LO) | | | | | | |
| <i>V_{OH_LO1}</i> | LO Leading Edge High-Level Output Voltage | --- | 12.6 | --- | V | I _o = 0A |
| <i>V_{OH_LO2}</i> | LO Steady State High-Level Output Voltage | --- | 10.8 | --- | | |
| <i>V_{OH_HO}</i> | HO High-Level Output Voltage | --- | VBS | --- | | |
| <i>V_{OL}</i> | Low-Level Output Voltage | --- | COM | --- | | |
| <i>t_R</i> | Output Rise Time | --- | 120 | --- | ns | C _{HO} =1nF, C _{LO} =1nF |
| <i>t_F</i> | Output Fall Time | --- | 50 | --- | | |
| <i>I_{o+}</i> | Output Source Current | --- | 180 | --- | mA | |
| <i>I_{o-}</i> | Output Sink Current | --- | 260 | --- | | |
| Bootstrap FET Characteristics | | | | | | |
| <i>V_{B_ON}</i> | VB when the bootstrap FET is on | --- | 14.0 | --- | V | LO = 'HIGH' |
| <i>I_{B_CAP}</i> | VB source current when FET is on | --- | 23.0 | --- | mA | CBS = 0.1uF |
| <i>I_{B_10V}</i> | VB source current when FET is on | --- | 4.2 | --- | | VB = 10V |

Pin Assignments and Definitions


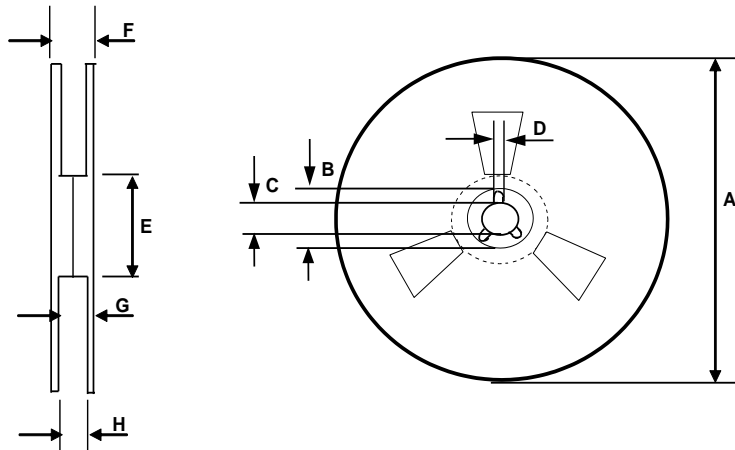
| Name | No. | Description |
|------------|-----|---|
| VCC | 1 | Logic and internal gate drive supply voltage |
| COM | 2 | IC power and signal ground |
| FB | 3 | Lamp current feedback input |
| VCO | 4 | Voltage-controlled oscillator (VCO) input |
| LO | 5 | Half-bridge low-side gate driver output |
| VS | 6 | High voltage floating supply return and half-bridge sensing input |
| HO | 7 | High-side gate driver output |
| VB | 8 | High-side gate driver floating supply |

State Diagram


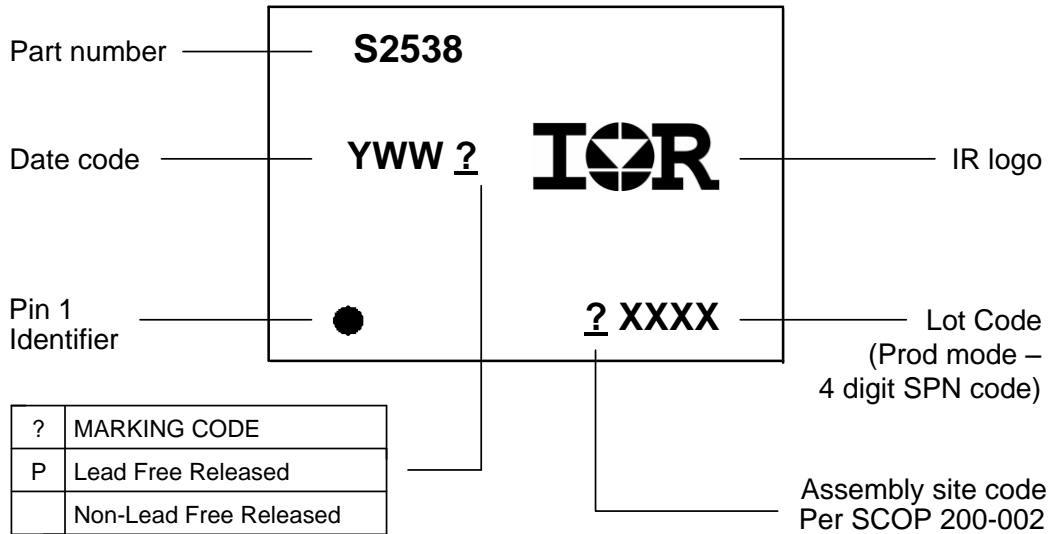
Package Details: SO8N


Tape and Reel Details: SO8N

CARRIER TAPE DIMENSION FOR 8SOICN

| Code | Metric | | Imperial | |
|------|--------|-------|----------|-------|
| | Min | Max | Min | Max |
| A | 7.90 | 8.10 | 0.311 | 0.318 |
| B | 3.90 | 4.10 | 0.153 | 0.161 |
| C | 11.70 | 12.30 | 0.46 | 0.484 |
| D | 5.45 | 5.55 | 0.214 | 0.218 |
| E | 6.30 | 6.50 | 0.248 | 0.255 |
| F | 5.10 | 5.30 | 0.200 | 0.208 |
| G | 1.50 | n/a | 0.059 | n/a |
| H | 1.50 | 1.60 | 0.059 | 0.062 |


REEL DIMENSIONS FOR 8SOICN

| Code | Metric | | Imperial | |
|------|--------|--------|----------|--------|
| | Min | Max | Min | Max |
| A | 329.60 | 330.25 | 12.976 | 13.001 |
| B | 20.95 | 21.45 | 0.824 | 0.844 |
| C | 12.80 | 13.20 | 0.503 | 0.519 |
| D | 1.95 | 2.45 | 0.767 | 0.096 |
| E | 98.00 | 102.00 | 3.858 | 4.015 |
| F | n/a | 18.40 | n/a | 0.724 |
| G | 14.50 | 17.10 | 0.570 | 0.673 |
| H | 12.40 | 14.40 | 0.488 | 0.566 |

Part Marking Information: SO8N


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