

# IR53H(D)420(-P2)

## SELF-OSCILLATING HALF BRIDGE

### Features

- Output power MOSFETs in half-bridge configuration
- High side gate drive designed for bootstrap operation
- Bootstrap diode integrated into package (HD type)
- Tighter initial deadtime control
- Low temperature coefficient deadtime
- 15.6V zener clamped Vcc for offline operation
- Half-bridge output is out of phase with R<sub>T</sub>
- True micropower startup
- Shutdown feature (1/6th V<sub>CC</sub>) on C<sub>T</sub> lead
- Increased undervoltage lockout hysteresis (1V<sub>olt</sub>)
- Lower power level-shifting circuit
- Lower di/dt gate drive for better noise immunity
- Excellent latch immunity on all inputs and outputs
- ESD protection on all leads
- Constant V<sub>O</sub> pulse width at startup
- Heatsink package version (P2 type)

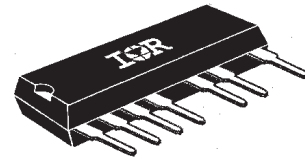
### Description

The IR53H(D)420(-P2) are complete high voltage, high speed, self-oscillating half-bridge circuits. Proprietary HVIC and latch immune CMOS technologies, along with the HEXFET® power MOSFET technology, enable ruggedized single package construction. The front-end features a programmable oscillator which functions similar to the CMOS 555 timer. The supply to the control circuit has a zener clamp to simplify offline operation. The output features two HEXFETs in a half-bridge configuration with an internally set deadtime designed for minimum cross-conduction in the half-bridge. Propagation delays

### Product Summary

|                                        |              |
|----------------------------------------|--------------|
| V <sub>IN</sub> (max)                  | 500V         |
| Duty Cycle                             | 50%          |
| Deadtime (type.)                       | 1.2μs        |
| R <sub>ds(on)</sub>                    | 3.0Ω         |
| P <sub>D</sub> (T <sub>A</sub> = 25°C) | 2.0W or 3.0W |

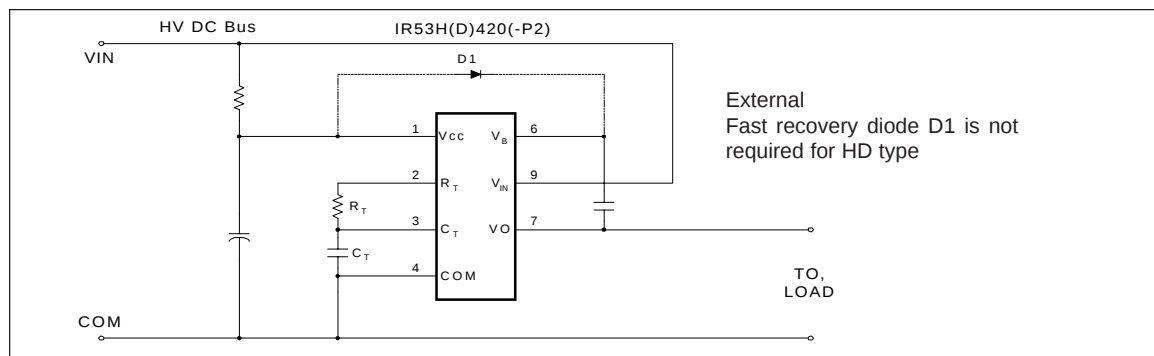
### Package



7 Pin Lead SIP

for the high and low side power MOSFETs are matched to simplify use in 50% duty cycle applications. The device can operate up to the V<sub>IN</sub> (max) rating.

### Typical Connection



## 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, unless stated otherwise. All currents are defined positive into any lead. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions.

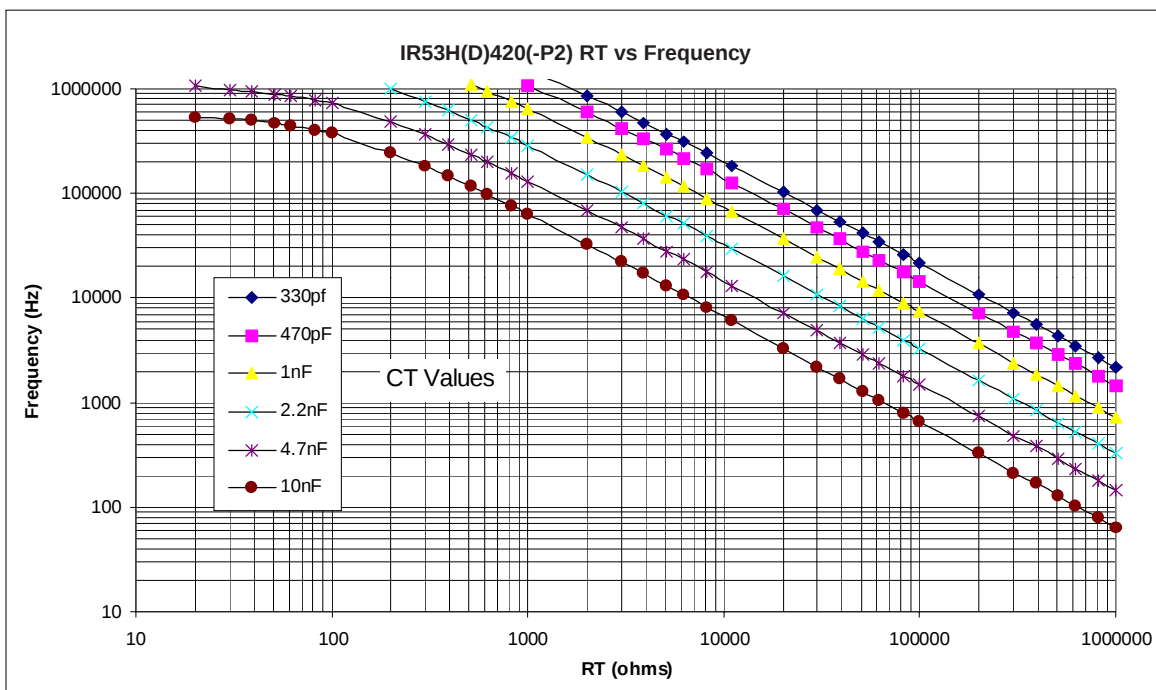
| Symbol     | Definition                                               | Minimum     | Maximum        | Units              |
|------------|----------------------------------------------------------|-------------|----------------|--------------------|
| $V_{IN}$   | High voltage supply                                      | - 0.3       | 500            | V                  |
| $V_B$      | High side floating supply                                | $V_O - 0.3$ | $V_O + 25$     |                    |
| $V_O$      | Half-bridge output                                       | -0.3        | $V_{IN} + 0.3$ |                    |
| $V_{RT}$   | $R_T$ voltage                                            | - 0.3       | $V_{CC} + 0.3$ |                    |
| $V_{CT}$   | $C_T$ voltage                                            | - 0.3       | $V_{CC} + 0.3$ |                    |
| $I_{CC}$   | Supply current (note 1)                                  | —           | 25             | mA                 |
| $I_{RT}$   | $R_T$ output current                                     | - 5         | 5              | W                  |
| $dV/dt$    | Peak diode recovery                                      | —           | 3.50           |                    |
| $P_D$      | Package power dissipation @ $T_A \leq +25^\circ\text{C}$ | —           | 2              |                    |
|            | -P2                                                      | —           | 3              | $^\circ\text{C/W}$ |
| $R_{thJA}$ | Thermal resistance, junction to ambient                  | —           | 60             |                    |
|            | -P2                                                      | —           | 40             |                    |
| $R_{thJC}$ | Thermal resistance, junction to case<br>(heatsink)       | —           | 20             |                    |
| $T_J$      | Junction temperature                                     | -55         | 150            |                    |
| $T_S$      | Storage temperature                                      | -55         | 150            | $^\circ\text{C}$   |
| $T_L$      | Lead temperature (soldering, 10 seconds)                 | —           | 300            |                    |

### NOTE 1:

This IC contains a zener clamp structure between  $V_{CC}$  and COM which has a nominal breakdown voltage of 15.6V. Please note that this supply pin should not be driven by a DC, low impedance power source greater than the  $V_{CLAMP}$  specified in the Electrical Characteristics Section

## Recommended Component Values

| Symbol | Definition                | Minimum | Maximum | Units     |
|--------|---------------------------|---------|---------|-----------|
| $R_T$  | Timing resistor value     | 10      | —       | $k\Omega$ |
| $C_T$  | $C_T$ pin capacitor value | 330     | —       | pF        |



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## Recommended Operating Conditions

The input/output logic timing diagram is shown in figure 1. For proper operation, the device should be used within the recommended conditions.

| Symbol   | Definition                                            | Minimum       | Maximum           | Units            |
|----------|-------------------------------------------------------|---------------|-------------------|------------------|
| $V_B$    | High side floating supply absolute voltage            | $V_O + 10$    | $V_O + V_{clamp}$ | V                |
| $V_{IN}$ | High voltage supply                                   | —             | 500               |                  |
| $V_O$    | Half-bridge output voltage                            | -3.0 (note 3) | 500               |                  |
| $I_D$    | Continuous drain current ( $T_A = 25^\circ\text{C}$ ) | —             | 0.7               | A                |
|          | -P2                                                   | —             | 0.85              |                  |
|          | ( $T_A = 85^\circ\text{C}$ )                          | —             | 0.5               |                  |
|          | -P2                                                   | —             | 0.6               |                  |
|          | ( $T_C = 25^\circ\text{C}$ ) -P2                      | —             | 1.2               |                  |
| $I_{CC}$ | Supply current                                        | (note 3)      | 5                 | mA               |
| $T_A$    | Ambient temperature                                   | -40           | 125               | $^\circ\text{C}$ |

### NOTE 2:

Care should be taken to avoid switching conditions where the  $V_S$  node flies inductively below ground by more than 5V.

### NOTE 3:

Enough current should be supplied to the  $V_{CC}$  lead of the IC to keep the internal 15.6V zener diode clamping the voltage at this lead.

## Electrical Characteristics

$V_{BIAS}$  ( $V_{CC}$ ,  $V_{BS}$ ) = 12V,  $C_T = 1$  nF and  $T_A = 25^\circ\text{C}$  unless otherwise specified. The  $V_{IN}$ ,  $V_{TH}$  and  $I_{IN}$  parameters are referenced to COM.

| MOSFET Characteristics  |                                             |      |      |      |       |                       |                  |
|-------------------------|---------------------------------------------|------|------|------|-------|-----------------------|------------------|
| Symbol                  | Definition                                  | Min. | Typ. | Max. | Units | Test Conditions       |                  |
| t <sub>rr</sub>         | Reverse recovery time (MOSFET body diode)   | —    | 240  | —    |       | I <sub>F</sub> =700mA | di/dt = 100 A/μs |
| Q <sub>rr</sub>         | Reverse recovery charge (MOSFET body diode) | —    | 0.5  | —    | μC    |                       |                  |
| R <sub>ds(on)</sub>     | Static drain-to-source on resistance        | —    | 3.0  | —    | Ω     |                       |                  |
| V <sub>SD</sub>         | Diode forward voltage                       | —    | 0.8  | —    | V     |                       |                  |
| Dynamic Characteristics |                                             |      |      |      |       |                       |                  |
| Symbol                  | Definition                                  | Min. | Typ. | Max. | Units | Test Conditions       |                  |
| D                       | RT duty cycle                               | —    | 50   | —    | %     | fosc = 20 kHz         |                  |
| t <sub>sd</sub>         | Shutdown propagation delay                  | —    | 660  | —    | nsec  |                       |                  |

## Electrical Characteristics

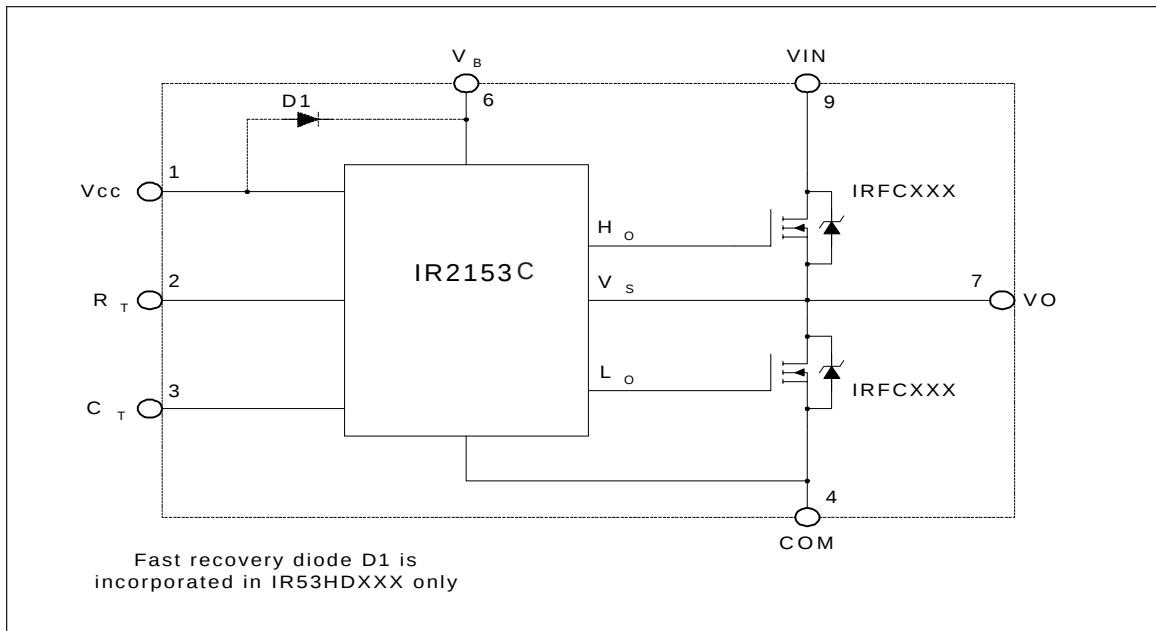
$V_{BIAS}$  ( $V_{CC}$ ,  $V_{BS}$ ) = 12V,  $C_T$  = 1 nF and  $T_A$  = 25°C unless otherwise specified. The  $V_{IN}$ ,  $V_{TH}$  and  $I_{IN}$  parameters are referenced to COM.

| Low Voltage Supply Characteristics |                                                                             |      |       |      |         |                                        |
|------------------------------------|-----------------------------------------------------------------------------|------|-------|------|---------|----------------------------------------|
| Symbol                             | Definition                                                                  | Min. | Typ.  | Max. | Units   | Test Conditions                        |
| $V_{CCUV+}$                        | Rising $V_{CC}$ undervoltage lockout threshold                              | 8.1  | 9.0   | 9.9  | V       |                                        |
| $V_{CCUV-}$                        | Falling $V_{CC}$ undervoltage lockout threshold                             | 7.2  | 8.0   | 8.8  |         |                                        |
| $V_{CCUVH}$                        | $V_{CC}$ undervoltage lockout Hysteresis                                    | 0.5  | 1.0   | 1.5  |         |                                        |
| $I_{QCCUV}$                        | Micropower startup $V_{CC}$ supply current                                  | —    | 75    | 150  | $\mu A$ | $V_{CC} \leq V_{CCUV-}$                |
| $I_{QCC}$                          | Quiescent $V_{CC}$ supply current                                           | —    | 500   | 950  |         |                                        |
| $V_{CLAMP}$                        | $V_{CC}$ zener clamp voltage                                                | 14.4 | 15.6  | 16.8 | V       | $I_{CC} = 5mA$                         |
| Floating Supply Characteristics    |                                                                             |      |       |      |         |                                        |
| Symbol                             | Definition                                                                  | Min. | Typ.  | Max. | Units   | Test Conditions                        |
| $I_{QBSUV}$                        | Micropower startup $V_{BS}$ supply current                                  | —    | 0     | 10   | $\mu A$ | $V_{CC} \leq V_{CCUV-}$                |
| $I_{QBS}$                          | Quiescent $V_{BS}$ supply current                                           | —    | 30    | 50   |         |                                        |
| $V_{BSMIN}$                        | Minimum required $V_{BS}$ voltage for proper functionality from $R_T$ to HO | —    | 4.0   | 5.0  | V       | $V_{CC} = V_{CCUV+} + 0.1V$            |
| $I_{OS}$                           | Offset supply leakage current                                               | —    | —     | 50   | $\mu A$ | $V_B = V_S = 600V$                     |
| $V_F$                              | Bootstrap diode forward voltage (IR2153D)                                   | 0.5  | —     | 1.0  | V       | $I_F = 250mA$                          |
| Oscillator I/O Characteristics     |                                                                             |      |       |      |         |                                        |
| Symbol                             | Definition                                                                  | Min. | Typ.  | Max. | Units   | Test Conditions                        |
| $f_{osc}$                          | Oscillator frequency                                                        | 19.4 | 20    | 20.6 | kHz     | $R_T = 36.9k\Omega$                    |
|                                    |                                                                             | 94   | 100   | 106  |         | $R_T = 7.43k\Omega$                    |
| $d$                                | $R_T$ pin duty cycle                                                        | 48   | 50    | 52   | %       | $f_o < 100kHz$                         |
| $I_{CT}$                           | $C_T$ pin current                                                           | —    | 0.001 | 1.0  | $\mu A$ |                                        |
| $I_{CTUV}$                         | UV-mode $C_T$ pin pulldown current                                          | 0.30 | 0.70  | 1.2  | mA      | $V_{CC} = 7V$                          |
| $V_{CT+}$                          | Upper $C_T$ ramp voltage threshold                                          | —    | 8.0   | —    | V       |                                        |
| $V_{CT-}$                          | Lower $C_T$ ramp voltage threshold                                          | —    | 4.0   | —    |         |                                        |
| $V_{CTSD}$                         | $C_T$ voltage shutdown threshold                                            | 1.8  | 2.1   | 2.4  |         |                                        |
| $V_{RT+}$                          | High-level $R_T$ output voltage, $V_{CC} - V_{RT}$                          | —    | 10    | 50   | mV      | $I_{RT} = 100\mu A$                    |
|                                    |                                                                             | —    | 100   | 300  |         | $I_{RT} = 1mA$                         |
| $V_{RT-}$                          | Low-level $R_T$ output voltage                                              | —    | 10    | 50   |         | $I_{RT} = 100\mu A$                    |
|                                    |                                                                             | —    | 100   | 300  |         | $I_{RT} = 1mA$                         |
| $V_{RTUV}$                         | UV-mode $R_T$ output voltage                                                | —    | 0     | 100  |         | $V_{CC} \leq V_{CCUV-}$                |
| $V_{RTSD}$                         | SD-Mode $R_T$ output voltage, $V_{CC} - V_{RT}$                             | —    | 10    | 50   |         | $I_{RT} = 100\mu A$ ,<br>$V_{CT} = 0V$ |
|                                    |                                                                             | —    | 10    | 300  |         | $I_{RT} = 1mA$ ,<br>$V_{CT} = 0V$      |

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## Functional Block Diagram



Technical drawing of a 12-pin D-subminiature connector. The drawing includes three views: a top view, a side view, and a front view. Dimensions are provided in millimeters (mm) and inches (in).

**Top View Dimensions:**

- Overall width: 23.11 (.910) mm, 22.61 (.890) mm (labeled -A-)
- Pin pitch (center-to-center): 2.54 (.100) mm (labeled 4X)
- Pin diameter: 0.558 (.022) mm, 0.458 (.018) mm (labeled 7X)
- Pin length: 1.65 (.065) mm, 1.40 (.055) mm (labeled 7X)
- Pin spacing (center-to-center): 1.87 (.074) mm, 1.30 (.051) mm (labeled 7X)
- Pin diameter tolerance:  $\pm 0.25 (.010)$  mm (labeled M C A S B)
- Pin length tolerance: 0.25 (.010) mm (labeled 2X)

**Side View Dimensions:**

- Overall height: 3.68 (.145) mm, 3.18 (.125) mm (labeled -B-)
- Pin height: 3.55 (.140) mm, 3.05 (.120) mm (labeled 7X)
- Pin diameter: 0.558 (.022) mm, 0.458 (.018) mm (labeled 7X)
- Pin length: 1.87 (.074) mm, 1.30 (.051) mm (labeled 7X)
- Pin diameter tolerance:  $\pm 0.25 (.010)$  mm (labeled M C A S B)
- Pin length tolerance: 0.25 (.010) mm (labeled 2X)

**Front View Dimensions:**

- Overall width: 16.89 (.665) mm, 16.63 (.655) mm
- Pin height: 3.18 (.125) mm, 2.92 (.115) mm

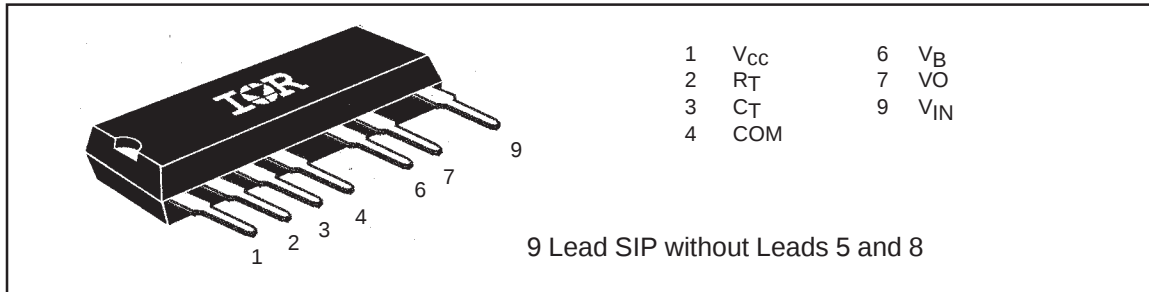
**NOTES:**

1. Dimensioning and tolerancing per ANSI Y14.5M-1982
2. Controlling dimension: Inch
3. Dimensions are shown in millimeters (inches)

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## Lead Assignments



## Lead Definitions

| Symbol          | Lead Description                              |
|-----------------|-----------------------------------------------|
| V <sub>CC</sub> | Logic and internal gate drive supply voltage. |
| R <sub>T</sub>  | Oscillator timing resistor output             |
| C <sub>T</sub>  | Oscillator timing capacitor input             |
| V <sub>B</sub>  | High side gate drive floating supply.         |
| V <sub>IN</sub> | High voltage supply                           |
| V <sub>O</sub>  | Half Bridge output                            |
| COM             | Logic and low side of half bridge return      |

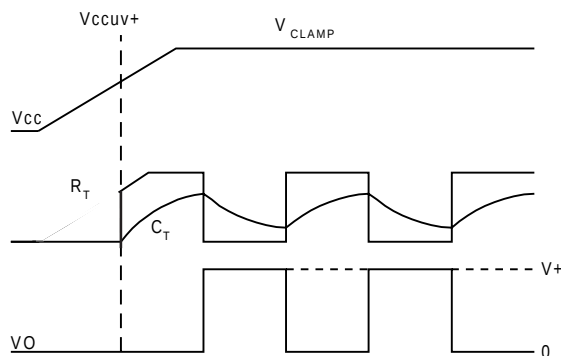


Figure 1. Input/Output Timing Diagram

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