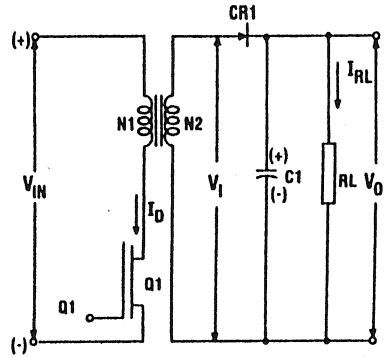
Copy CL13 L13

## TYPE OF CONVERTER

Flyback

## CIRCUIT CONFIGURATION




## IDEAL TRANSFER FUNCTION

$$\frac{V_O}{V_{IN}} = \frac{N_2}{N_1}\left(\frac{t_{on}}{T_S - t_{on}}\right) = \frac{N_2}{N_1}\left(\frac{D}{1-D}\right.$$

## PEAK DRAIN CURRENT *

$$I_{DMAX} = I_{RL}\left(\frac{N_2}{N_1}\right)\left(\frac{1}{1-D}\right) + \frac{\Delta I_L}{2}$$

## PEAK DRAIN VOLTAGE *

$$V_{DS} = V_{IN} + \left(\frac{N_1}{N_2}\right)(V_{OUT} + V_D$$

## AVERAGE DIODE CURRENTS *

$$I_{CR1} = I_{RL}$$

## DIODE VOLTAGES (VRM) *

$$V_{RM} = V_{IN}\left(\frac{N_2}{N_1}\right)$$

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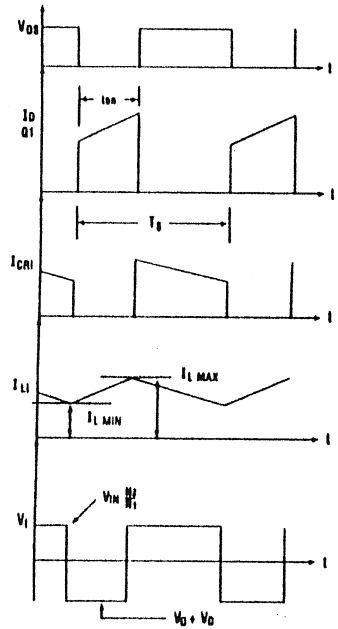
## VOLTAGE AND CURRENT WAVEFORMS




## ADVANTAGES

Drain current reduced by turns ratio of transfor
Low parts count. Isolation. Has no secondary
put inductors.

## DISADVANTAGES

Poor transformer utilization. Transformer st
energy. High output ripple. CR1 needs fast re
recovery.

## TYPICAL APPLICATIONS

Low output power. Supports multiple outputs

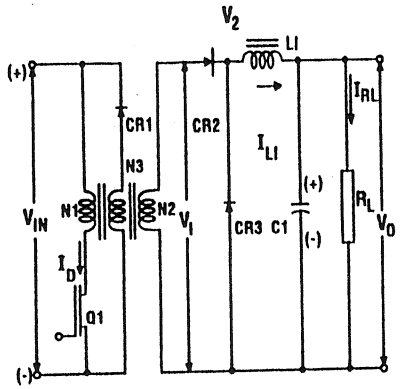
## APPLICABLE HARRIS PRODUCTS

HIP5061, ICL7667, HV400

## TYPE OF CONVERTER

Forward

## CIRCUIT CONFIGURATION




## IDEAL TRANSFER FUNCTION

$$\frac{V_O}{V_{IN}} = \frac{N_2}{N_1}\left(\frac{t_{on}}{T_S}\right) = \frac{N_2}{N_1} = (D)$$

## PEAK DRAIN CURRENT *

$$I_{DMAX} = \frac{N_2}{N_1}\left(I_{RL} + \frac{\Delta I_{LI}}{2}\right) + \hat{I}_{MAG}$$

($\hat{I}_{MAG}$ = peak magnetizing current.)

## PEAK DRAIN VOLTAGE *

$$V_{DS} = V_{IN}\left(1 + \frac{N_1}{N_3}\right)$$

## AVERAGE DIODE CURRENTS *

$$I_{CR1} = \frac{\hat{I}_{MAG}}{2}(D)$$

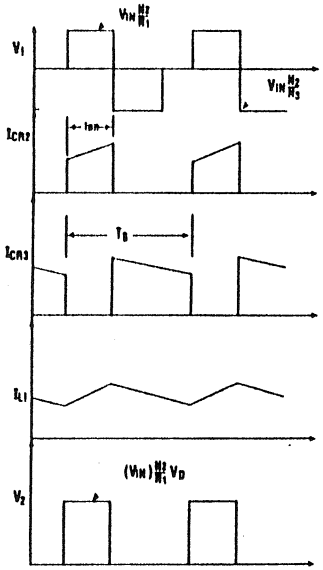
$$I_{CR2} = I_{RL}(D)$$

$$I_{CR3} = I_{RL}(1\text{-}D)$$

## DIODE VOLTAGES (VRM) *

$$V_{RM}\begin{cases} V_{CR1} = V_{IN}\left(1 + \frac{N_3}{N_1}\right) \\ V_{CR2} = V_{IN}\left(\frac{N_2}{N_3}\right) \\ V_{CR3} = V_{IN}\left(\frac{N_2}{N_1}\right) \end{cases}$$

## VOLTAGE AND CURRENT WAVEFORMS




## ADVANTAGES

Drain current reduced by ratio of $N_2/N_1$. Low output ripple.

## DISADVANTAGES

Poor transformer utilization. Poor transient response. Transformer design is critical. Transformer reset limits duty ratio. High voltage required for Q1. High input current ripple.

## TYPICAL APPLICATIONS

Low-to-moderate output power. Supports multiple outputs.

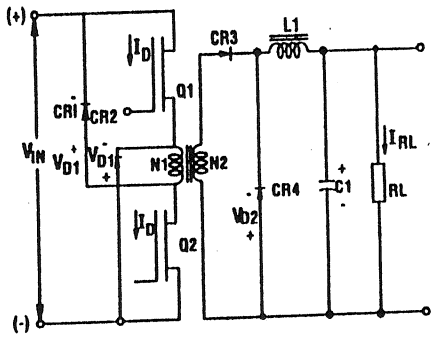
## APPLICABLE HARRIS PRODUCTS

HIP5061, ICL7667, HV400

## TYPE OF CONVERTER

Two-Switch Forward

## CIRCUIT CONFIGURATION




## IDEAL TRANSFER FUNCTION

$$\frac{V_O}{V_{IN}} = \frac{N_2}{N_1}\left(\frac{t_{on}}{T_S}\right) = \frac{N_2}{N_1}(D)$$

## PEAK DRAIN CURRENT *

$$I_{DMAX} = \frac{N_2}{N_1}\left(I_{RL} + \frac{\Delta I_{L1}}{2}\right) + \hat{I}_{MAG}$$

($\hat{I}_{MAG}$ = Peak magnetizing current.)

## PEAK DRAIN VOLTAGE *

$(Q_1 \text{ or } Q_2) \quad V_{DS} = V_{IN} + V_{D1}$

## AVERAGE DIODE CURRENTS *

$$I_{CR1,AVE} = I_{CR2,AVE} = \frac{\hat{I}_{MAG}}{2} D$$

$$I_{CR3,AVE} = I_{RL} D$$

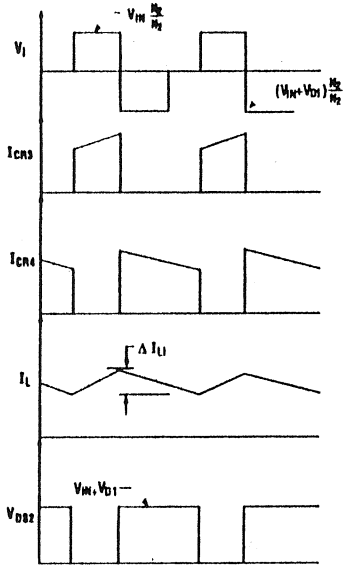
$$I_{CR4,AVE} = I_{RL}(1-D)$$

## DIODE VOLTAGES (VRM) *

$$V_{CR1,PK} = V_{CR2,PK} = V_{IN}$$

$$V_{CR3} = V_{CR4} = \left(\frac{N_2}{N_1}\right) V_{IN}$$

## VOLTAGE AND CURRENT WAVEFORMS




## ADVANTAGES

Drain currents reduced by turns ratio. Lossless snubber recovers energy. Drain voltage 1/2 that of conventional forward converter. Low output ripple.

## DISADVANTAGES

Poor transformer utilization, high parts count, high-side switch drive required. Transformer reset limits its duty ratio. High input current ripple.

## TYPICAL APPLICATIONS

High input voltage, moderate power. Supports multiple outputs.

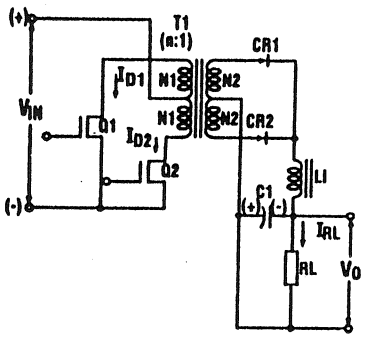
## APPLICABLE HARRIS PRODUCTS

HIP2500, HV400

## TYPE OF CONVERTER

Push-Pull

## CIRCUIT CONFIGURATION




## IDEAL TRANSFER FUNCTION

$$\frac{V_O}{V_{IN}} = 2\frac{N_2}{N_1}\left(\frac{t_{on}}{T_S}\right) = 2\frac{N_2}{N_1}(D)$$

## PEAK DRAIN CURRENT *

$$I_{DMAX} = \frac{N_2}{N_1}\left(I_{RL} + \frac{\Delta I_{L1}}{2}\right) + \hat{I}_{MAG}$$

($\hat{I}_{MAG}$ = Peak magnetizing current.)

## PEAK DRAIN VOLTAGE *

$$V_{DS} = 2\ V_{IN}$$

## AVERAGE DIODE CURRENTS *

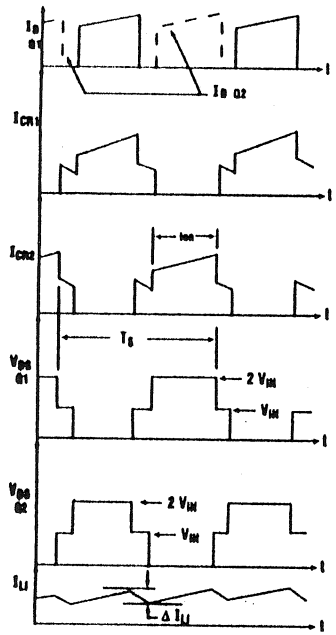
$$I_{CR1} = \frac{I_{RL}}{2}$$

$$I_{CR2} = \frac{I_{RL}}{2}$$

## DIODE VOLTAGES (VRM) *

$$V_{RM}\begin{cases} V_{CR1} = 2V_{IN}\left(\frac{N_2}{N_1}\right) \\ V_{CR2} = 2V_{IN}\left(\frac{N_2}{N_1}\right) \end{cases}$$

## VOLTAGE AND CURRENT WAVEFORMS




## ADVANTAGES

Good transformer utilization. Drain current reduced as a function of $N_2/N_1$. Good at low values of $V_{IN}$. Low output ripple.

## DISADVANTAGES

Cross conduction of Q1 and Q2 possible, high parts count. Transformer design critical. High voltage required for Q1 and Q2. High input current ripple.

## TYPICAL APPLICATIONS

Low input voltage.

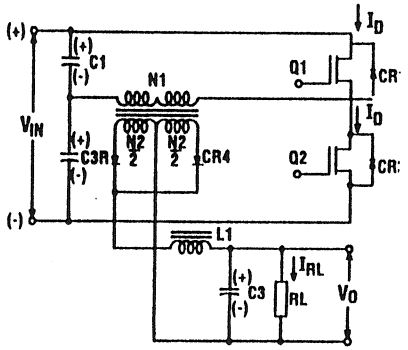
## APPLICABLE HARRIS PRODUCTS

HIP5062, HIP5061

## TYPE OF CONVERTER

Half Bridge

## CIRCUIT CONFIGURATION




## IDEAL TRANSFER FUNCTION

$$\frac{V_O}{V_{IN}} = \frac{N_2}{N_1}\left(\frac{t_{on}}{T_S}\right) = \frac{N_2}{N_1}(D)$$

## PEAK DRAIN CURRENT *

$$I_{DMAX} = \frac{N_2}{N_1}\left(I_{RL} + \frac{\Delta I_{L1}}{2}\right) + \hat{I}_M$$

($\hat{I}_{MAG}$ = Peak magnetizing current.)

## PEAK DRAIN VOLTAGE *

$$V_{DS} = V_{IN}$$

## AVERAGE DIODE CURRENTS *

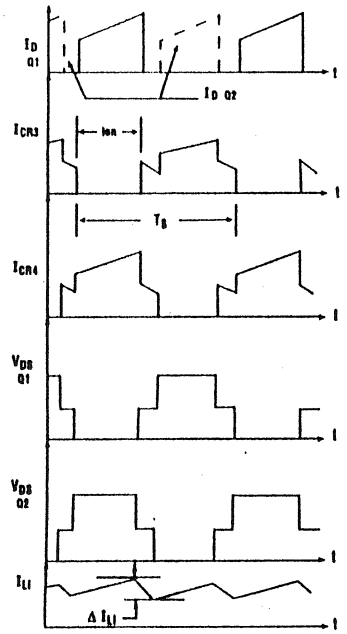
$$I_{CR3} = \frac{I_{RL}}{2}$$

$$I_{CR4} = \frac{I_{RL}}{2}$$

## DIODE VOLTAGES (VRM) *

$$V_{RM}\begin{cases} V_{CR3} = V_{IN}\left(\frac{N_2}{N_1}\right) \\ V_{CR4} = V_{IN}\left(\frac{N_2}{N_1}\right) \end{cases}$$

## VOLTAGE AND CURRENT WAVEFORMS




## ADVANTAGES

Good transformer utilization. Transistors rated at $V_{IN}$, isolation, multiple outputs. ID reduced as a ratio of $N_2/N_1$. High power output. Zero voltage switching possible, near D = 1. Low output ripple.

## DISADVANTAGES

Poor transient response, high parts count, C1 and C2 have high ripple current. Requires high side switch drive. Cross conduction of Q1 and Q2 possible. High input current ripple.

## TYPICAL APPLICATIONS

High input voltage, moderate-to-high power.

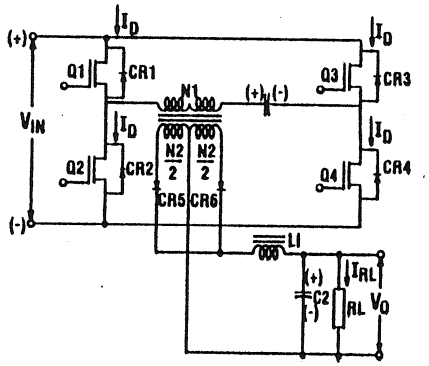
## APPLICABLE HARRIS PRODUCTS

HIP2500, HIP5500, HV400

## TYPE OF CONVERTER

Full Bridge

## CIRCUIT CONFIGURATION




## IDEAL TRANSFER FUNCTION

$$\frac{V_O}{V_{IN}} = 2\frac{N_2}{N_1}\left(\frac{t_{on}}{T_S}\right) = 2\frac{N_2}{N_1}(D)$$

## PEAK DRAIN CURRENT *

$$I_{DMAX} = \frac{N_2}{N_1}\left(I_{RL} + \frac{\Delta I_{LI}}{2}\right) + \hat{I}_{MAG}$$

($\hat{I}_{MAG}$ = Peak magnetizing current.)

## PEAK DRAIN VOLTAGE *

$$V_{DS} = V_{IN}$$

## AVERAGE DIODE CURRENTS *

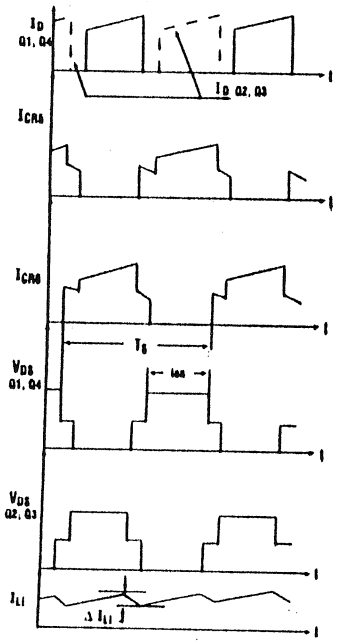
$$I_{CR5} = I_{RL}$$

$$I_{CR6} = I_{RL}$$

## DIODE VOLTAGES (VRM) *

$$V_{RM}\begin{cases} V_{CR5} = 2V_{IN}\left(\frac{N_2}{N_1}\right) V_{CR1} = V_{IN} \\ V_{CR6} = 2V_{IN}\left(\frac{N_2}{N_1}\right) V_{CR2} = V_{IN} \end{cases}$$

## VOLTAGE AND CURRENT WAVEFORMS




## ADVANTAGES

Good transformer utilization, transistors rated at $V_{IN}$, isolation, multiple outputs. ID is reduced as a ratio of $N_2/N_1$. Zero voltage switching possible.Low output ripple.

## DISADVANTAGES

High parts count. C1 has high ripple current. Requires high side switch drive. Cross conduction of Q1 and Q2 or Q3 and Q4 possible. High input current ripple.

## TYPICAL APPLICATIONS

High power, high input voltage.

## APPLICABLE HARRIS PRODUCTS

HIP4080/81. HIP2500 HV400