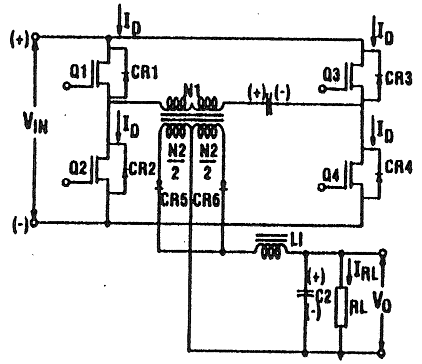
TYPE OF CONVERTER

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 *

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

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

PEAK DRAIN VOLTAGE *

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

AVERAGE DIODE CURRENTS *

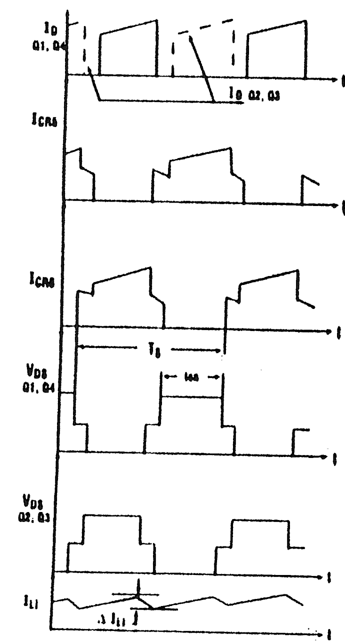
$$I_{CR5} = I_{RL}$$

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

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.

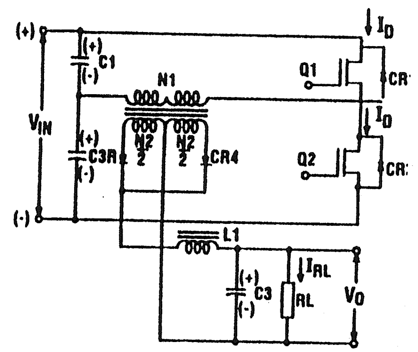
APPLICABLE HARRIS PRODUCTS

HIP4080/81, HIP2500, HV-400

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 *

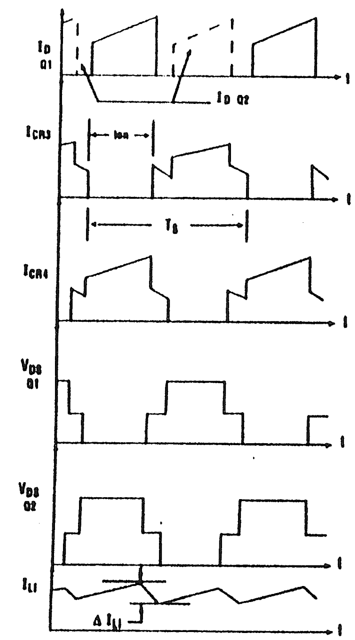
$$I_{CR3} = \frac{I_{RL}}{2}$$

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

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.

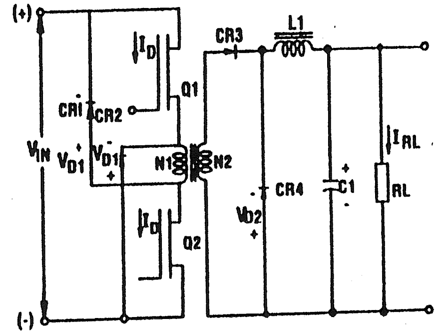
APPLICABLE HARRIS PRODUCTS

HIP2500, HIP5500, HV400

TYPE OF CONVERTER

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

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

AVERAGE DIODE CURRENTS

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

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

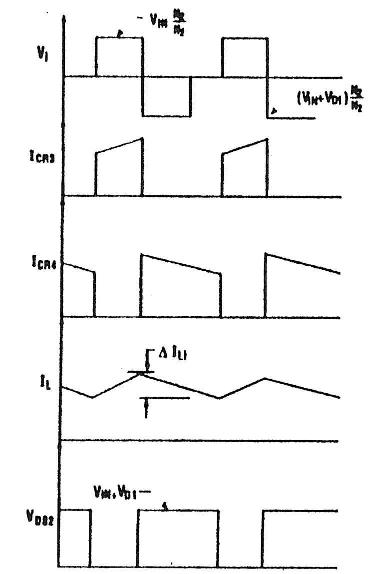
$$I_{CR4,AVE} = I_{RL}(1-D)$$

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 duty ratio. High input current ripple.

TYPICAL APPLICATIONS

High input voltage, moderate power. Supports multiple outputs.

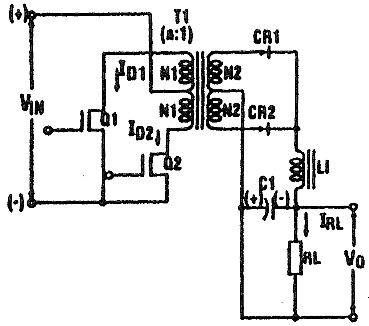
APPLICABLE HARRIS PRODUCTS

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 *

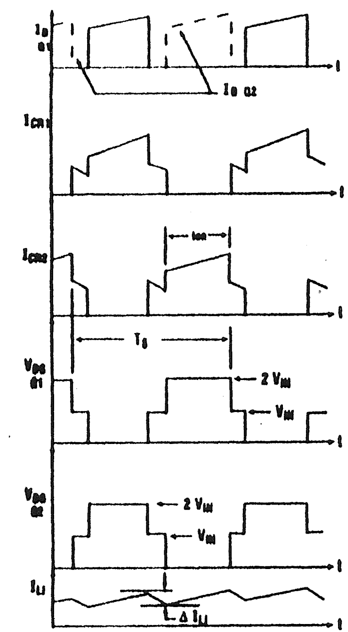
$$I_{CR1} = \frac{I_{RL}}{2}$$

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

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.

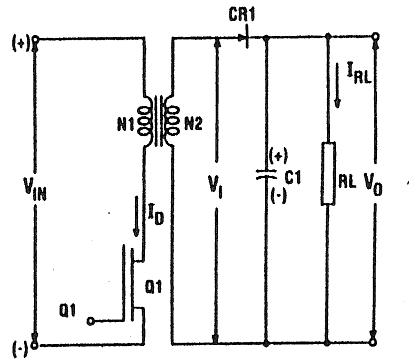
APPLICABLE HARRIS PRODUCTS

HIP5062, HIP5061

TYPE OF CONVERTER

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 *

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

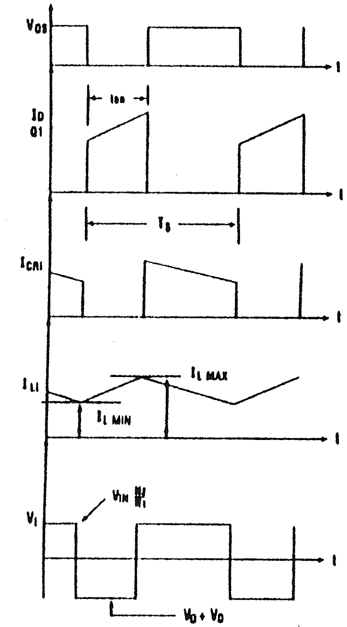
AVERAGE DIODE CURRENTS *

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

DIODE VOLTAGES (VRM) *

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

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 sl energy. High output ripple. CR1 needs fast re recovery.

TYPICAL APPLICATIONS

Low output power. Supports multiple outputs

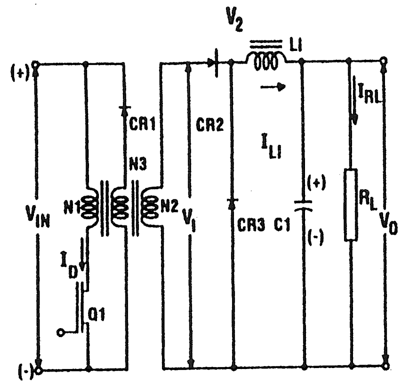
APPLICABLE HARRIS PRODUCTS

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

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

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

PEAK DRAIN VOLTAGE

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

AVERAGE DIODE CURRENTS

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

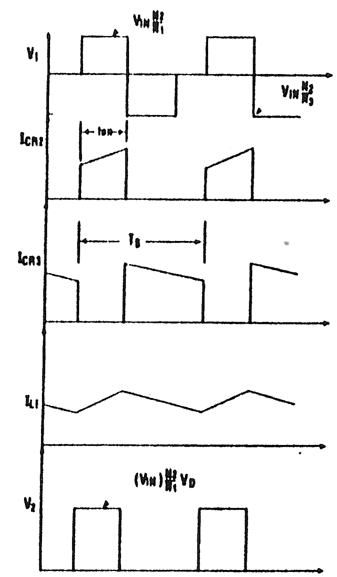
$$I_{CR2} = I_{RL}(D)$$

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

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.

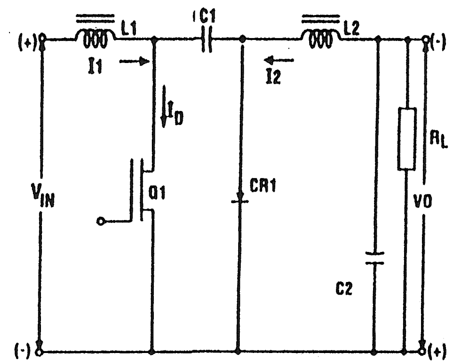
APPLICABLE HARRIS PRODUCTS

HIP5061, ICL7667, HV400

TYPE OF CONVERTER

CUK (Step Up/Down)

CIRCUIT CONFIGURATION



IDEAL TRANSFER FUNCTION

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

PEAK DRAIN CURRENT

$$I_{DMAX} = I_1 + I_2 = I_1\left(\frac{1}{D}\right)$$

PEAK DRAIN VOLTAGE

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

AVERAGE DIODE CURRENTS

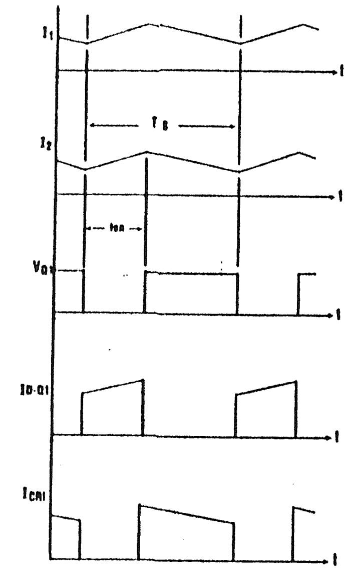
$$I_{CR1} = I_1 + I_2$$

$$I_1 + I_2 = I_1\left(\frac{1}{D}\right)$$

DIODE VOLTAGES (VRM)

$$V_{RM} = V_O + V_{IN}$$

VOLTAGE AND CURRENT WAVEFORMS



ADVANTAGES

Simple, low ripple input and output current, capacitive isolation protects against switch failure.

DISADVANTAGES

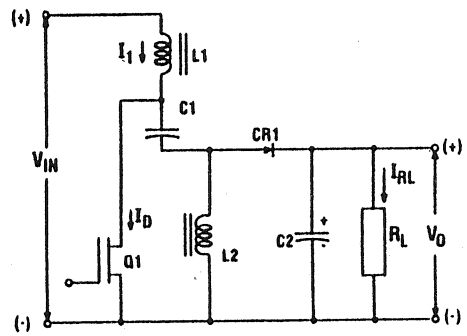
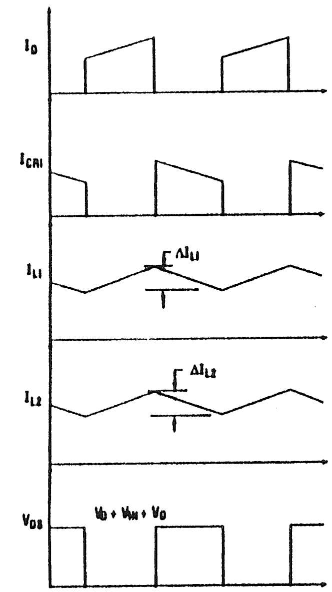
High drain current. C1 has high ripple current requirement (low ESR). High voltage required for Q1. Voltage inversion.

TYPICAL APPLICATIONS

Low noise, inverse output voltages.

APPLICABLE HARRIS PRODUCTS

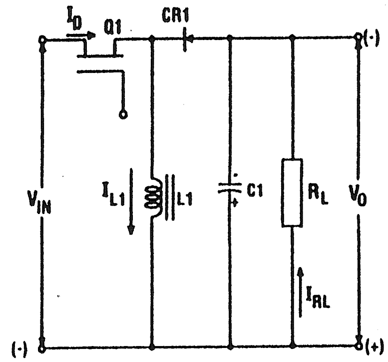
HIP5060, HIP5061, HIIP5062, HIP5063

TYPE OF CONVERTER	SEPIC (Step Down/Up)	**DIODE VOLTAGES (VRM)** *	$V_{RM} = V_O + V_{IN}$
CIRCUIT CONFIGURATION		**VOLTAGE AND CURRENT WAVEFORMS**	
IDEAL TRANSFER FUNCTION	$\frac{V_O}{V_I} = \frac{D}{1-D}$		
PEAK DRAIN CURRENT *	$I_{DMAX} = I_1 + I_{RL} + \frac{\Delta I_{L1} + \Delta I_{L2}}{2}$		
PEAK DRAIN VOLTAGE *	$V_{DS} = V_O + V_{IN} + V_D$	**ADVANTAGES**	Low ripple input current, step-up or step-down with no inversion, no transformer. Capacitive isolation protects against switch failure (unlike Buck).
AVERAGE DIODE CURRENTS *	$I_{CR1} = I_{RL}$	**DISADVANTAGES**	No isolation between input and output. Switch has high peak and rms currents which limit output power, C1 and C2 have high ripple current requirements (low ESR), continuous current mode makes loop stabilization difficult, potential instabilities with circuit-mode control. High output ripple.
		TYPICAL APPLICATIONS	Power-factor correction. High reliability. Wide input voltage range.
		APPLICABLE HARRIS PRODUCTS	HIP5060, HIP5061, HIP5062, HIP5063

TYPE OF CONVERTER

Buck - Boost (Step Down/Up)

CIRCUIT CONFIGURATION



IDEAL TRANSFER FUNCTION

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

PEAK DRAIN CURRENT *

$$I_{DMAX} = I_{RL}\left(\frac{1}{1-D}\right) + \frac{\Delta I_{L1}}{2}$$

PEAK DRAIN VOLTAGE *

$$V_{DS} = V_{IN} + V_O + V_D$$

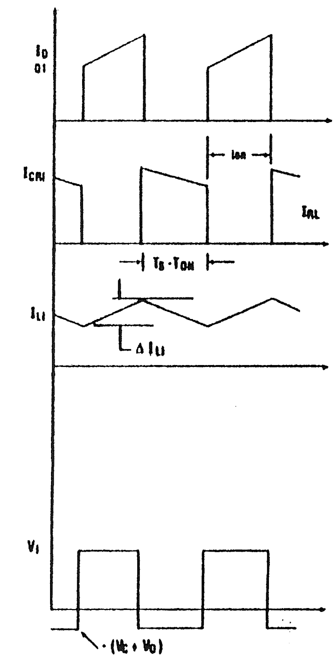
AVERAGE DIODE CURRENTS *

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

DIODE VOLTAGES (VRM) *

$$V_{RM} = V_O + V_{IN}$$

VOLTAGE AND CURRENT WAVEFORMS



ADVANTAGES

Voltage inversion without using a transformer, simple, high frequency operation.

DISADVANTAGES

No Isolation between input and output. Only one output is possible. Regulator loop hard to stabilize. High-side switch drive required. High output ripple. High input ripple current.

TYPICAL APPLICATIONS

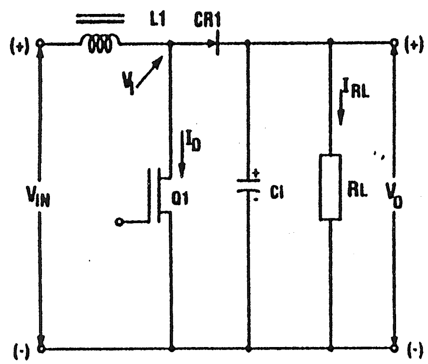
Inverse output voltages.

APPLICABLE HARRIS PRODUCTS

TYPE OF CONVERTER

Boost (Step Up)

CIRCUIT CONFIGURATION



IDEAL TRANSFER FUNCTION

$$\frac{V_O}{V_{IN}} = \frac{T_S}{T_S - t_{on}} = \frac{1}{(1-D)}$$

PEAK DRAIN CURRENT

$$I_{DMAX} = I_{RL}\left(\frac{1}{1-D}\right) + \frac{\Delta I_{L1}}{2}$$

PEAK DRAIN VOLTAGE

$$V_{DS} = V_O + V_D$$

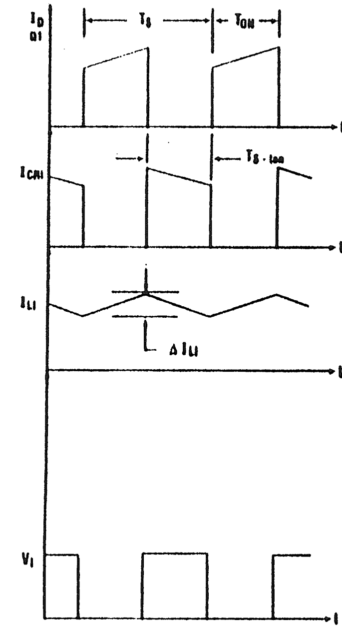
AVERAGE DIODE CURRENTS

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

DIODE VOLTAGES (VRM) *

$$V_{RM} = V_O$$

VOLTAGE AND CURRENT WAVEFORMS



ADVANTAGES

High efficiency, simple, no transformer. Low input ripple current.

DISADVANTAGES

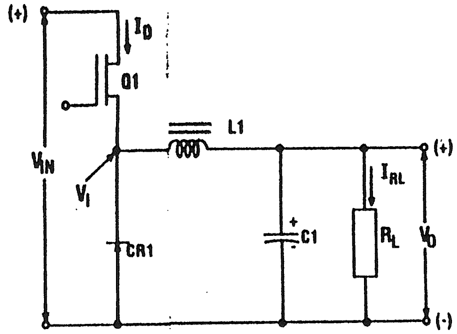
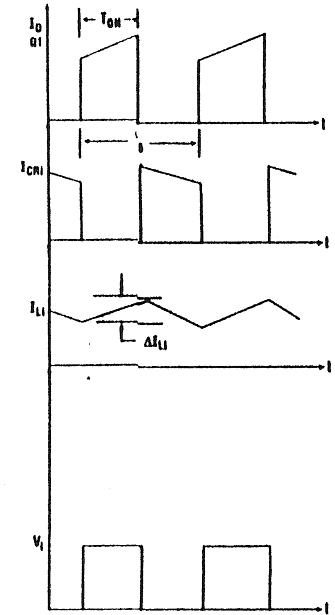
No isolation between input and output. High peak collector current. Only one output is possible. Regulator loop hard to stabilize. High output ripple. Unable to control short-circuit current.

TYPICAL APPLICATIONS

Power-factor correction. Battery up-converters.

APPLICABLE HARRIS PRODUCTS

HIP5061, ICL7667, HV400

TYPE OF CONVERTER	Buck (Step Down)
CIRCUIT CONFIGURATION	
IDEAL TRANSFER FUNCTION	$\frac{V_O}{V_{IN}} = \frac{t_{on}}{T_S} = D$
PEAK DRAIN CURRENT *	$I_{DMAX} = I_{RL} + \frac{\Delta I_{L1}}{2}$
PEAK DRAIN VOLTAGE *	$V_{DS} = V_{IN} + V_D$
AVERAGE DIODE CURRENTS *	$I_{CR1} = I_{RL}\ (1\text{-}D)$
DIODE VOLTAGES (VRM) *	$V_{RM} = V_{IN}$
VOLTAGE AND CURRENT WAVEFORMS	
ADVANTAGES	High efficiency, simple, no transformer, low switch stress. Small outpu filter, low ripple.
DISADVANTAGES	No isolation betwen input and output. Potential over-voltage if Q1 siorts. Only one output possible. High-side switch dive required. High input ripple current.
TYPICAL APPLICATIONS	Small size, imbeddid systems.
APPLICABLE HARRIS PRODUCTS	HIP5600 w/P-IGBT For off line CKTS.