



# BHE30S DC/DC CONVERTER

High Efficiency 30W, 2:1, 4:1 Input Range

US Patent 5,777,519

## Key Features

- Wide input voltage range 4:1 & 2:1
- Less than 60mV output noise
- Efficiency up to 93%
- Six-sided shielding
- Soft start
- Hiccup short circuit protection
- Adjustable output
- 1mA off state current
- 50µS transient response
- Industry standard pinouts



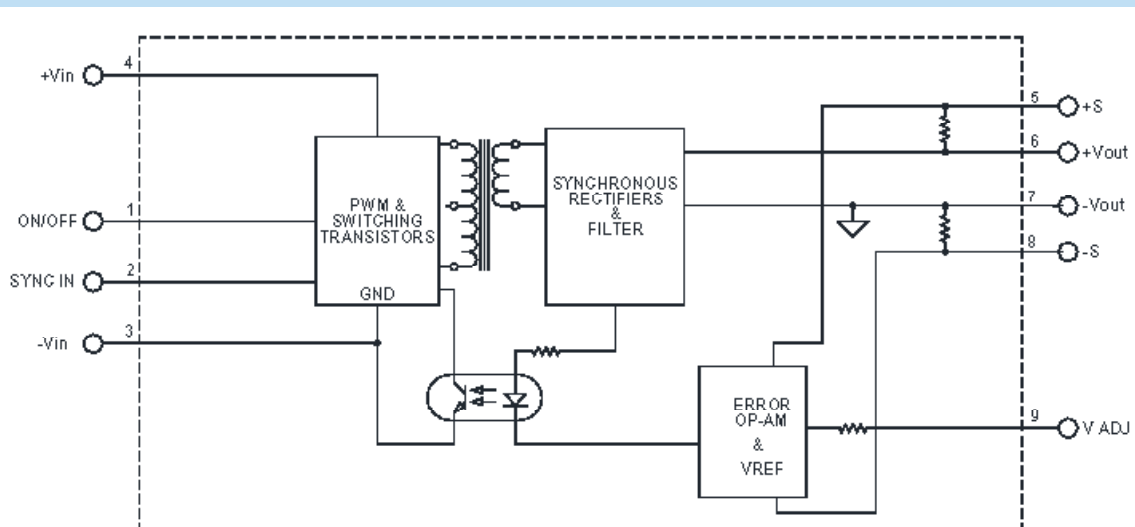
Beta Dyne is protected under various patents, including but not limited to U.S. Patent numbers: 5,777,519; 6,188,276; 6,262,901; 6,452,818; 6,473,3171.

## Applications

- High-Resolution Data Converters
- Instrumentation
- Test & Measurement
- Telecom

## Functional Description

The BHE30 series is a family of high-performance, low-noise, isolated DC/DC converters consisting of single output models. The converter incorporates low switching noise techniques at its input and synchronous rectification on the output to provide 30W of output power at 93% efficiency in a 1.98x1.58x.40 case. It's high efficiency and SMT Technology allow the converter to operate from -40°C to +75°C without derating. All models are designed to meet the BASIC requirements of UL/EN60950-1 and CE mark.



Typical Block Diagram of BHE30 Single Output Converter

## Electrical Specifications

### INPUT SPECIFICATIONS

Unless otherwise specified, all parameters are given under typical +25°C with nominal input voltage and under full output load conditions.

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Input Voltage Range	See Model Selection Guide				
Input Filter	LC				
Reverse Polarity Input Current	External series-blocking diode			12	A
Input Surge Current (20µS Spike)				10	A
Short Circuit Current Limit			150		% I <sub>IN</sub>
Undervoltage Shutdown, 12V <sub>in</sub> D Models		7			Vdc
Undervoltage Shutdown, 24V <sub>in</sub> D Models		13			Vdc
Undervoltage Shutdown, 48V <sub>in</sub> D Models		28			Vdc
Undervoltage Shutdown, 24V <sub>in</sub> Q Models		7			Vdc
Undervoltage Shutdown, 48V <sub>in</sub> Q Models		13			Vdc
Off State Current,			2		mA
Remote ON/OFF Control, Positive Logic	Standard on All Model				
Converter ON	Open (Open Collector)				
Converter OFF		-0.6	0	0.2	Vdc
Logic Input Reference	-Input				
Logic Compatibility	TTL Open Collector or CMOS Open Drain				
Remote ON/OFF Control, Negative Logic	"N" Suffix				
Converter ON	ON (Pulled low to 0-0.6V)				
Converter OFF	Open(Open Collector)				
Logic Input Reference	-Input				
Logic Compability	Standard TTL Logic				

### OUTPUT SPECIFICATIONS

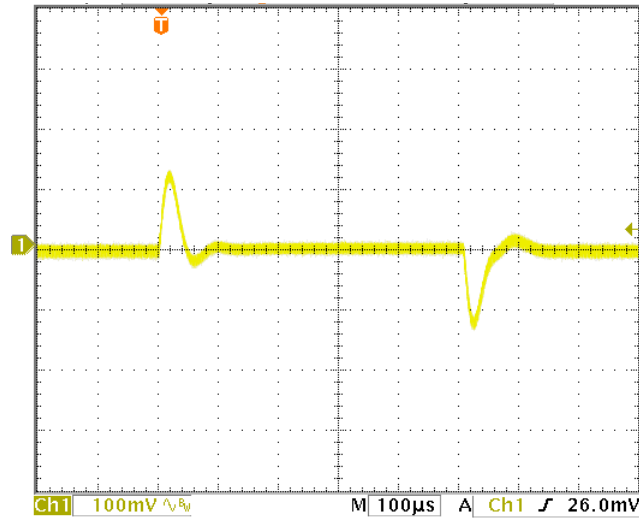
PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Voltage and Current Ratings	See Model Selection Guide				
Output Voltage Accuracy, Single Only			±1	±1.5	%
Output Voltage Adjustment, Single Only	See figure 9		5	±10	%
Minimum Load		None			% of FL
Ripple & Noise (20 MHz Bandwidth)	See Figure		1	1.5	% of V <sub>PP</sub>
Line Regulation, Single	Minimum V <sub>IN</sub> to maximum V <sub>IN</sub>		±.5	±1.0	%
Load Regulation, Single	NL to FL		±.2	±.5	%
Temperature Coefficient @ FL			0.02		%/°C of V <sub>OUT</sub>
Transient Response Time (to within 0.5% of V <sub>OUT</sub> )	50% FL to FL to 50% FL, See Figure 1		50		µS
Short Circuit Protection	All outputs, by Hiccup technique				

### ENVIROMENTAL & GENERAL SPECIFICATIONS

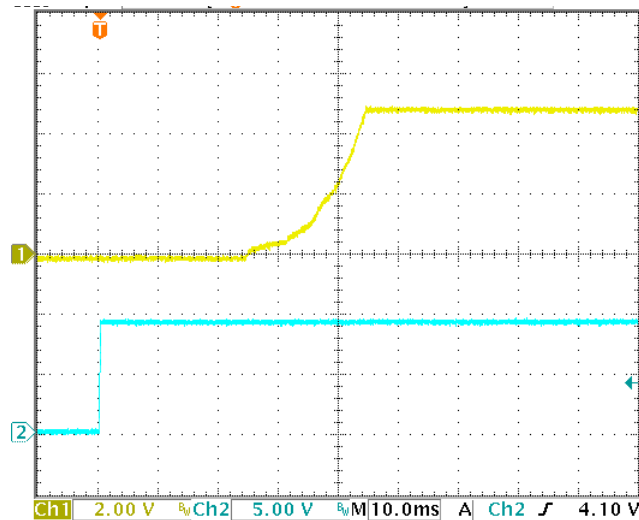
PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Efficiency	See Model Selection Guide				
Isolation Voltage (1 min.)			1500		Vdc
Isolation Resistance			100		MΩ
Isolation Capacitance			1090		pF
Switching Frequency			200		kHz
MTBF	per MIL-HNBK-217F(Ground Benign, +25C)		1 x 10 <sup>6</sup>		Hours
Thermal Resistance			1.0		°C/W
Operating Temperature, Industrial		-40		+75	°C/W
Maximum Operating Case Temperature				110	°C
EMI/RFI	Six-sided continuous shielded metal case				
Humidity	Up to 95% non-condensing				

**PHYSICAL CHARACTERISTICS**

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Dimensions (L×W×H)	1.98×1.58×0.400 in. (50.29×40.13×10.16mm)				
Weight	1.80 oz. (51.02g)				
Case Material	Coated metal				
Shielding Connection, 12, 24V <sub>IN</sub>	-Input (Pin 3)				
Shielding Connection, 48V <sub>IN</sub>	+Input (Pin 4)				



**FIGURE 1. Transient response of BHE30S5/6000/Q24 from Full load (6A) to Half Load (3A).**



**FIGURE 2. Start up & delay time of BHE30S5/6000/Q24 at V<sub>IN</sub>=24V and I<sub>OUT</sub>=6A.**

## Model Selection Guide

MODEL NUMBER	INPUT				OUTPUT		
	Voltage (Vdc)		Current (mA)		Voltage (Vdc)	Current (mA)	Efficiency Full Load (%)
	Nominal	Range	No Load	Full Load			
BHE30S2.5/10000/Q24	24	9-36	59	1187	+2.5	10000	87
BHE30S3.3/7500/Q24	24	9-36	86	1168	+3.3	7500	88
BHE30S5/5000/Q24	24	9-36	84	1176	+5	5000	88
BHE30S5/6000/Q24	24	9-36	84	1413	+5	6000	88
BHE30S12/2500/Q24	24	9-36	87	1384	+12	2500	90
BHE30S15/2000/Q24	24	9-36	122	1392	+15	2000	89
BHE30S2.5/10000/Q48	48	18-72	32	590	+2.5	10000	88
BHE30S3.3/7500/Q48	48	18-72	41	573	+3.3	7500	90
BHE30S5/5000/Q48	48	18-72	45	580	+5	5000	90
BHE30S5/6000/Q48	48	18-72	45	693	+5	6000	90
BHE30S12/2500/Q48	48	18-72	20	689	+12	2500	90
BHE30S12/3000/Q48	48	30-70	40	810	+12	3000	91
BHE30S15/2000/Q48	48	18-72	49	685	+15	2000	90
BHE30S2.5/10000/D12	12	9-18	TBD	TBD	+2.5	10000	TBD
BHE30S3.3/9000/D12	12	9-18	83	2794	+3.3	9000	88
BHE30S5/6000/D12	12	9-18	140	2771	+5	6000	90
BHE30S12/2500/D12	12	9-18	95	2799	+12	2500	90
BHE30S15/2000/D12	12	9-18	87	2712	+15	2000	91
BHE30S2.5/12000/D24	24	18-36	53	1437	+2.5	12000	88
BHE30S3.3/7500/D24	24	18-36	54	1129	+3.3	7500	91
BHE30S5/6000/D24	24	18-36	63	1359	+5	6000	92
BHE30S12/2500/D24	24	18-36	65	1358	+12	2500	92
BHE30S15/2000/D24	24	18-36	49	1334	+15	2000	93
BHE30S2.5/12000/D48	48	36-72	23	707	+2.5	12000	88
BHE30S3.3/9000/D48	48	36-72	32	685	+3.3	9000	90
BHE30S5/6000/D48	48	36-72	58	680	+5	6000	92
BHE30S12/2500/D48	48	36-72	35	678	+12	2500	92
BHE30S15/2000/D48	48	36-72	37	673	+15	2000	92

*Contact factory for custom input and output voltage combinations*

All BHE units come with the ON/OFF(pin 4) control function which is a positive polarity. If a negative polarity is required please add the suffix "N" to the part number. Standard on BHE units is the SYNC(pin 3), if not needed please add the suffix "NS" to the part number. Also the output sense(pin5&pin8) are standard on all units. If the output sense pins are not needed please add the suffix "NP" to the part number. See page 5 for ordering guide.

### ORDERING GUIDE

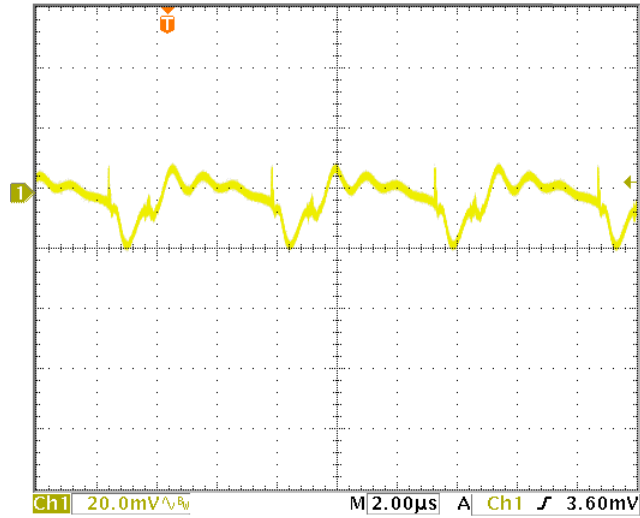
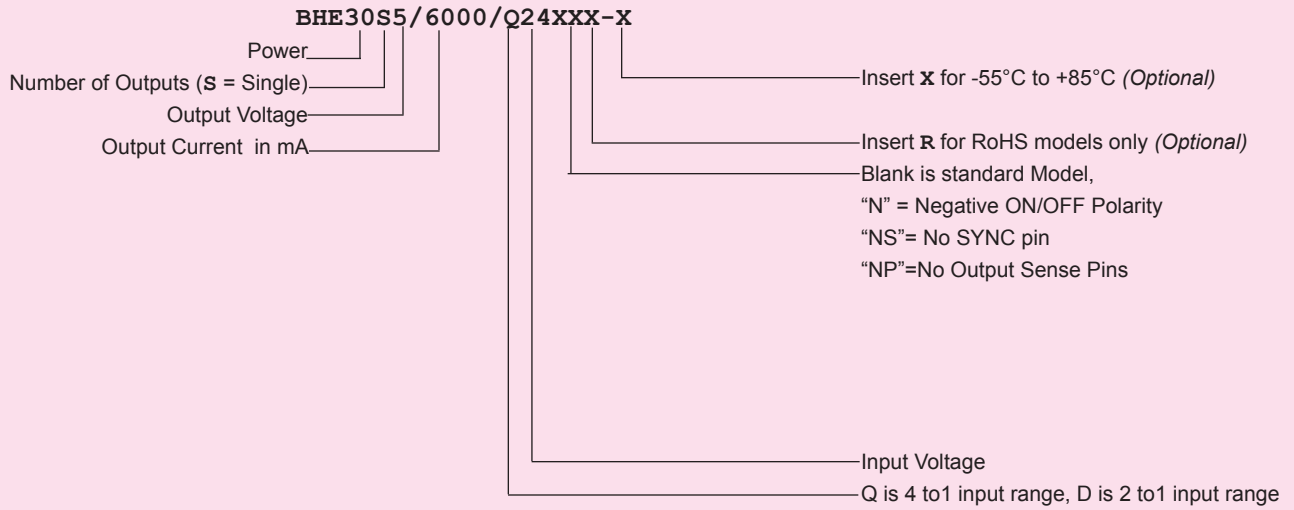


FIGURE 3. Typical output ripple of BHE30S5/6000/Q24 as shown in Figure 5.

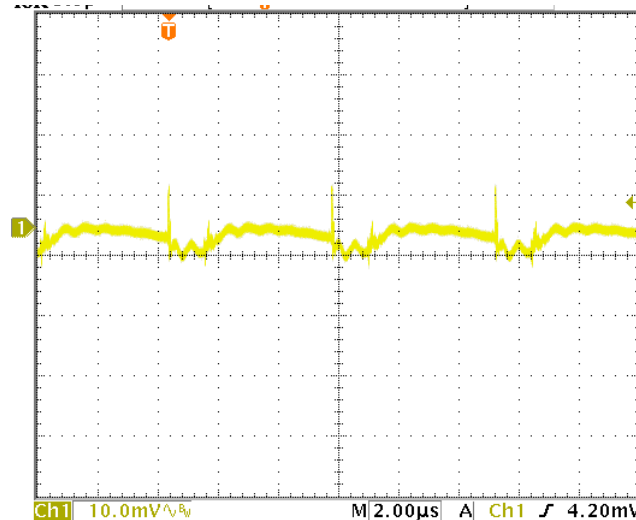
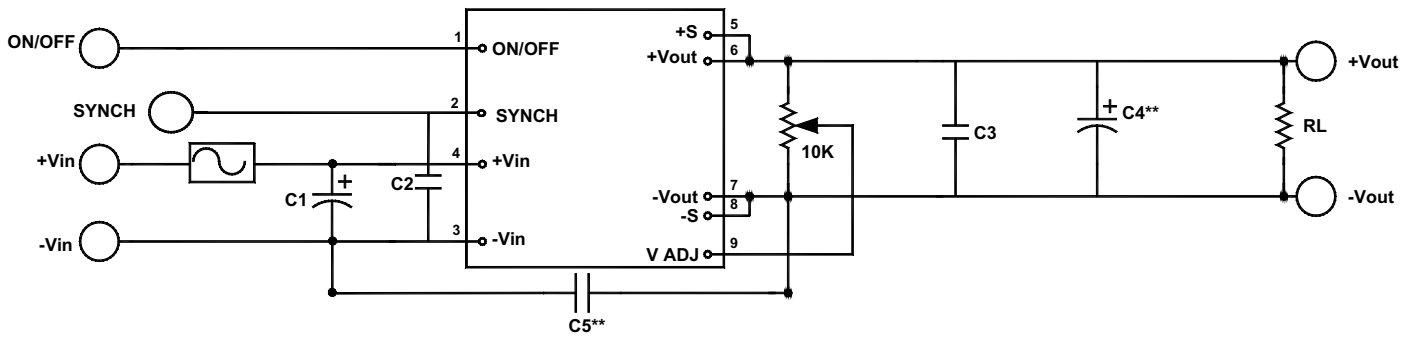


FIGURE 4. Typical output ripple of BHE30S5/6000/Q24 as shown in Figure 5 with an additional 180µF@16V low esr capacitor.

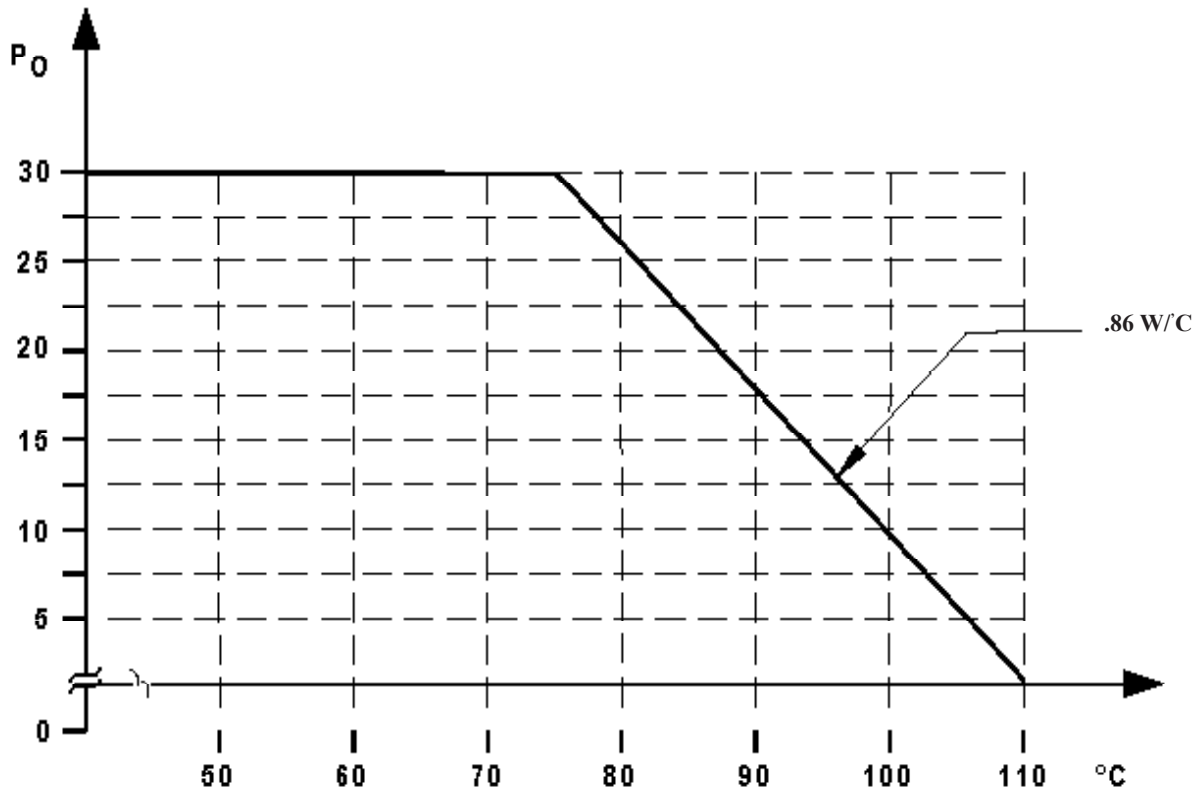


**\*\* OPTIONAL PART TO FURTHER REDUCE OUTPUT RIPPLE**

**C2=100p@50V, C3=1μF@25V ceramic, C4=180μF@16V low esr, C5 = .01-.1μF@1000V**

V <sub>IN</sub>	F1 (A)	C1 (Low ESR) (μF)	
12	6	47@25V	
24	3	22@50V	
48	3	10@100V	

**FIGURE 5. Typical connection diagram of BHE30S Single DC/DC Converter**



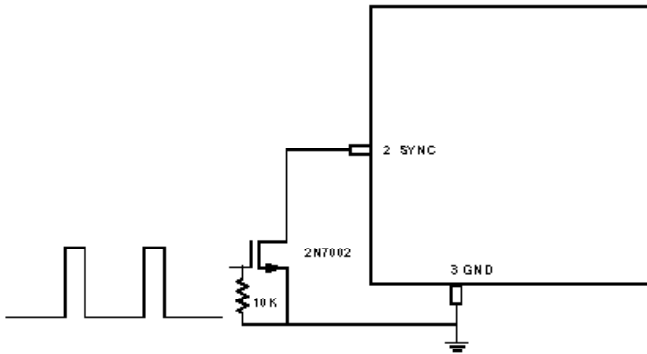
**FIGURE 6. Derating diagram of the BHE30S5/6000/Q24**

**EXTERNAL SYNCHRONIZATION**

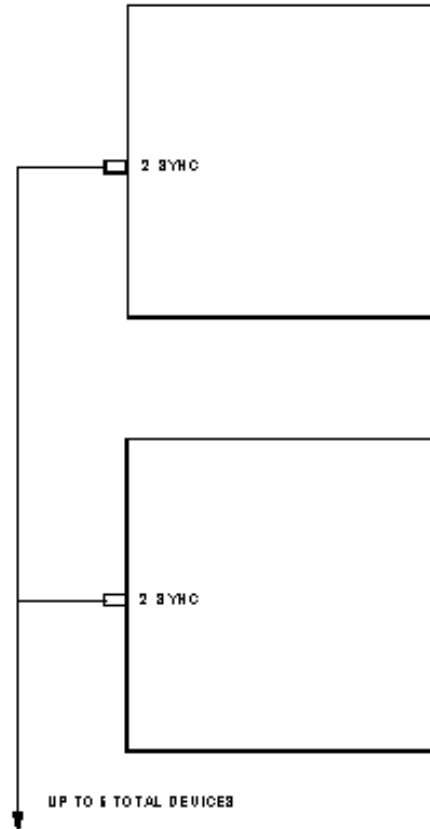
The SYNC pin can be used to synchronize the internal oscillator to external clock. An open drain output is the recommended interface between the external clock to the BHE30S SYNC pin as device shown in figure 7. The clock pulse width must be greater than 15ns. The external clock frequency must be greater than the frequency of the BHE30S.

Multiple BHE30S converters can be synchronized together simply by connecting the converters SYNC pins together as shown in figure 8.

Care should be taken to ensure the ground potential differences between the converters are minimized. In this configuration all the converters will be synchronized to the highest frequency device. The SYNC pin is a CMOS buffer with pull-up current limited to 200micro amps. If the external device forces the SYNC pin low before the internal oscillator ramp completes its charging cycle, the ramp will reset and another cycle begins. If the SYNC pins of multiple BHE30S converters are connected together, the first SYNC pin that pulls low will reset the oscillator ramp of all the other converters. All converters will operate in phase when synchronized using the SYNC feature. Up to five devices can be synchronized using this method.

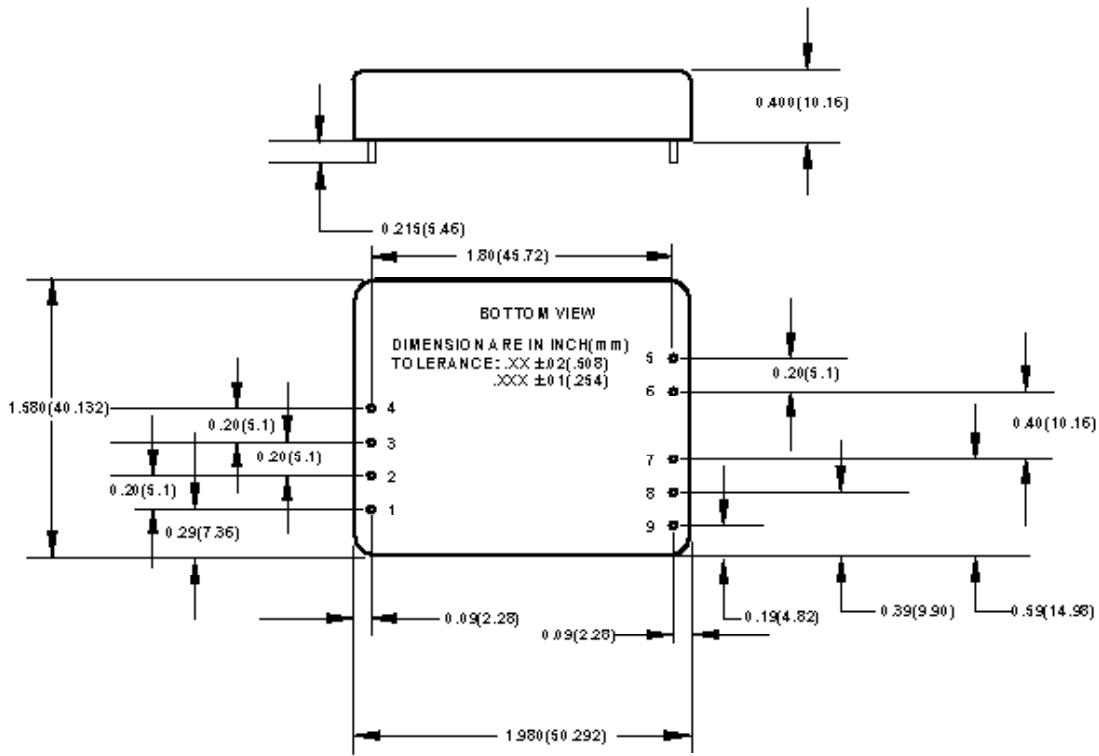


**FIGURE 7. SYNC from external clock**



**FIGURE 8. SYNC of multiple devices**

**MECHANICAL SPECIFICATIONS**



Pin	Function
	<b>SINGLE</b>
1	ON/OFF
2	SYNC
3	-V <sub>IN</sub>
4	+V <sub>IN</sub>
5	+SENSE
6	+V <sub>OUT</sub>
7	-V <sub>OUT</sub>
8	-SENSE
9	V <sub>OUT</sub> ADJ

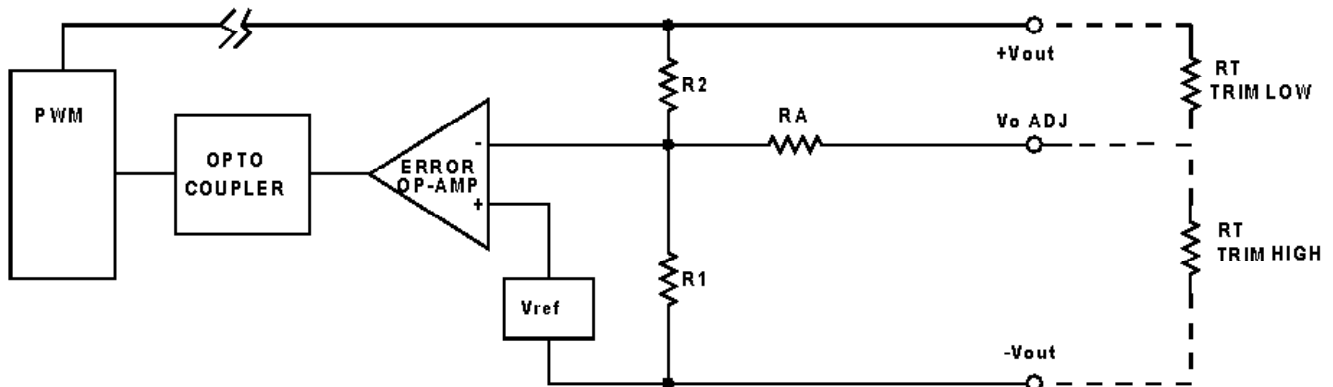


FIGURE 9. Typical connection diagram of BHE30S output adjustment circuit

Where V<sub>o</sub> is the required higher value:

$$R_{\text{TRIM HIGH}} = [(R_1 R_2 V_{\text{REF}}) / \{V_o R_1 - V_{\text{REF}}(R_1 + R_2)\}] - R_A \text{ in KOhm}$$

Where V<sub>o</sub> is the required lower value:

$$R_{\text{TRIM LOW}} = [(V_o - V_{\text{REF}}) R_1 R_2] / [(R_1 + R_2) V_{\text{REF}} - V_o R_1] - R_A \text{ in KOhm}$$

**Output Adjustment Component Values**

V <sub>OUT</sub> (V)	R <sub>2</sub> (KOhm)	R <sub>1</sub> (KOhm)	R <sub>A</sub> (KOhm)	V <sub>REF</sub> (V)
2.5	6.98	2.67	20K	.698
3.3	4.22	2.49	5.62	1.224
5	2.49	2.49	9.53	2.5
12	9.53	2.49	20.0	2.5
15	15.0	3.01	24.0	2.5