Chart 8.1 (cont.)

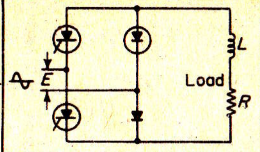
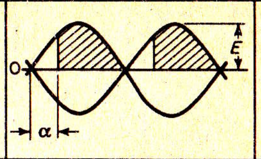
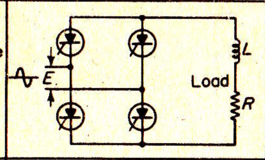
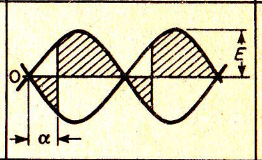
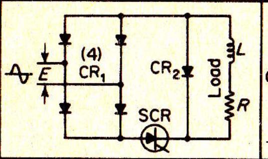
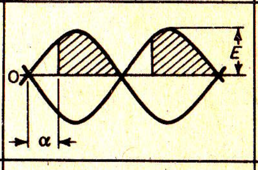
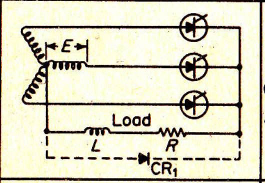
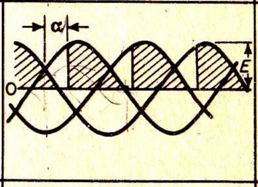
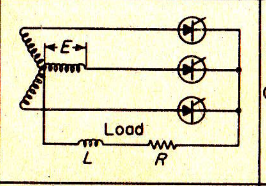
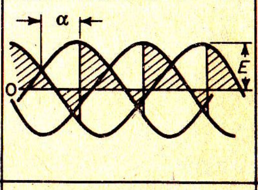
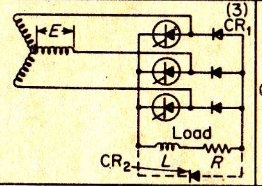
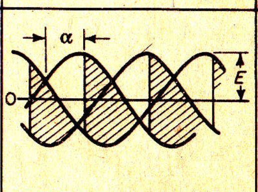
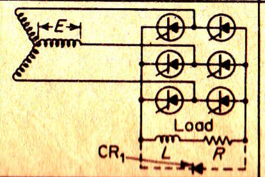
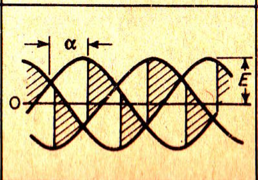
Circuit (a) Name	Circuit (b) Connections	(c) Load voltage waveforms	(d) Peak forward voltage on SCR	Peak reverse voltage (e) On SCR	Peak reverse voltage (f) On diode	(g) Max. load voltage ($\alpha = 0$) E_D = average d-c value E_a = RMS a-c value
(7) Single-phase bridge with 2 SCR's on common a-c line. Resistive or inductive load			E	E	E	$E_D = \frac{2E}{\pi}$
(8) Single-phase bridge with 4 SCR's and inductive load			E	E	—	$E_D = \frac{2E}{\pi}$
(9) Single-phase bridge with single SCR in d-c circuit. Resistive or inductive load			E	0	E (CR_1 and CR_2)	$E_D = \frac{2E}{\pi}$
(10) Three-phase half-wave with resistive load, or inductive load with free-wheeling rectifier			E (possibly $\sqrt{3}\,E$ if load open and if SCR's have high reverse currents	$\sqrt{3}\,E$	E	$E_D = \frac{3\sqrt{3}E}{2\pi}$
(11) Three-phase half-wave with inductive load (no free-wheeling rectifier)			$\sqrt{3}\,E$	$\sqrt{3}\,E$	—	$E_D = \frac{3\sqrt{3}E}{2\pi}$
(12) Three-phase bridge with 3 SCR's. Resistive load, or inductive load with free-wheeling rectifier			$\sqrt{3}\,E$	$\sqrt{3}\,E$	$\sqrt{3}\,E$	$E_D = \frac{3\sqrt{3}E}{\pi}$
(13) Three-phase bridge with 6 SCR's. Resistive load, or inductive load with free-wheeling rectifier			$\sqrt{3}\,E$ ($1.5E$ if SCR's shunted by resistance)	$\sqrt{3}\,E$	$\sqrt{3}\,E$	$E_D = \frac{3\sqrt{3}E}{\pi}$

Chart 8.1 (cont.)

(h) Load voltage vs trigger delay angle α	(j) Trigger angle range full ON to full OFF	Max. steady-state current in SCR (k) Average amp	Max. steady-state current in SCR (l) Cond. angle	Max. steady-state current in diode rectifier (m) Average amp	Max. steady-state current in diode rectifier (n) Cond. angle for max. current	(p) Ability to pumpback inductive load energy to supply line	(q) Fundamental frequency of load voltage (f = supply frequency)	(r) Notes and comments
$E_D = \frac{E}{\pi}(1 + \cos\alpha)$	180°	$\frac{E}{\pi R}$	180°	$\frac{E}{\pi R}$	180°	No	$2f$	Diode rectifiers act as free-wheeling path, conduct ($\pi + \alpha$) degrees with inductive load.
$E_D = \frac{2E}{\pi}\cos\alpha$ (assuming continuous current in load)	180°	$\frac{E}{\pi R}$	180°	—	—	Yes	$2f$	With resistive load operation is same as circuit (7).
$E_D = \frac{E}{\pi}(1 + \cos\alpha)$	180°	$\frac{2E}{\pi R}$	360°	$CR_1 = \frac{E}{\pi R}$ $CR_2 = 0.16\left(\frac{2E}{\pi R}\right)$	180° 148°	No	$2f$	CR_2 necessary when load is not purely resistive. Frequency limited by recovery characteristics of rectifiers and SCR's.
$E_D = \frac{3\sqrt{3}E}{2\pi}\cos\alpha$ $(0 < \alpha < 30°)$ $E_D = \frac{3E}{2\pi}[1 + \cos(\alpha + 30°)]$ $(30° < \alpha < 150°)$	150°	$\frac{\sqrt{3}E}{2\pi R}$	120°	$0.16\left(\frac{3\sqrt{3}E}{2\pi R}\right)$	134°	No	$3f$	
$E_D = \frac{3\sqrt{3}E}{2\pi}\cos\alpha$ (assuming continuous current in load)	150°	$\frac{\sqrt{3}E}{2\pi R}$	120°	—	—	Yes	$3f$	
$E_D = \frac{3\sqrt{3}E}{2\pi}(1 + \cos\alpha)$	180°	$\frac{\sqrt{3}E}{\pi R}$	120°	$CR_1 = \frac{\sqrt{3}E}{\pi R}$ $CR_2 = 0.14\left(\frac{3\sqrt{3}E}{\pi R}\right)$	120° 132°	No	$3f$	Without CR_2, SCR's may be unable to turn off an inductive load. Also, CR_2 relieves SCR's from free-wheeling duty.
$E_D = \frac{3\sqrt{3}E}{\pi}\cos\alpha$ $(0 < \alpha < 60°)$ $E_D = \frac{3\sqrt{3}E}{\pi}\left(1 + \frac{\cos\alpha}{2} - \frac{\sqrt{3}}{2}\sin\alpha\right)$ $(60° < \alpha < 120°)$	120°	$\frac{\sqrt{3}E}{\pi R}$	120°	$0.056\left(\frac{3\sqrt{3}E}{\pi R}\right)$	212°	No	$6f$	SCR's require two gate signals 60° apart each cycle, alternately a gate signal duration > 60°