## **CONTENTS**

ACKNOWLEDGEMENTS	ii
ABSTRACT	iii
CONTENTS	v
CHAPTER 1 INTRODUCTION	1
1.1 Brief Description of the HRR TEA CO <sub>2</sub> Laser	2
1.2 Choice of Circuit Elements for the HRR TEA CO <sub>2</sub> Laser	4
1.3 Objectives of this Project	6
1.4 Outline of this Thesis	6
CHAPTER 2 REVIEW OF HRR TEA CO <sub>2</sub> LASERS	7
2.1 Review of HRR TEA CO <sub>2</sub> Lasers and Excitation Circuits	7
2.1.1 Laser Performance	7
2.1.2 Excitation Circuits and Preionizers	10
2.1.3 Laser Chamber Designs	15
2.2 The Kinetic Processes in TEA CO <sub>2</sub> Laser	16
2.2.1 Vibrational States and Energy Levels	17
2.2.2 Upper Laser Level Excitation Mechanism	19
2.2.3 Laser Levels Relaxation Mechanism	20
2.3 Glow Discharge Formation and Instabilities	23
2.3.1 Effect of Preionization on Glow Discharge Formation	23

2	.3.2	Energy Input Period and Instabilities	245
2.4	Th	e E/N and Exicitation Efficiency	29
2.5	Pop	pulation Saturation in TEA CO <sub>2</sub> Laser	31
2.6	Fre	equency Limitations in HRR TEA CO <sub>2</sub> Laser	32
2	.6.1	General HRR Characteristics	33
2	.6.2	Effect of Boundary Layers	36
2	.6.3	Effects of Adiabatic Expansion and Heat Conduction	37
2	.6.4	Effects of Shock Waves and Acoustic Waves	40
2.7	Ga	s Degradation in HRR TEA CO <sub>2</sub> Laser	41
2	.7.1	Dissociation and Reformation Reactions	42
2	.7.2	Effects of Gas Mixture Degradation	44
2	.7.3	Electrical Parameters Effects on Gas Mixture Degradation	46
CH.	APT	ER 3 DESIGNS AND MEASUREMENTS	47
3.1	The	e Laser Chamber	47
3.2	The	e Chilled Water Unit	50
3.3	Far	n Array and Gas Flow Velocities	53
3.4	Pro	filed Electrode and Preionizer	56
3.5	Ov	erview of the Electrical Circuit	.59
3.6	Hig	gh-Voltage Power Supply and Protection	60
3.7	555	5 Timer and SCR Circuits	61
3.8	The	e High-Voltage Circuit	66
3	.8.1	Spark Gaps Design	69
3	.8.2	Low-Pass Filter and Pulse Transformers	69

3.8.3	3 Steep-Triggering Circuit	72
3.8.4	4 Suppression of Electrical Oscillations	74
3.8.5	5 Spark Gaps Performances	76
CHAP	TER 4 RESULTS AND DISCUSSIONS	81
4.1 S	ingle-Pulse Optimization	81
4.1.1	Laser Beam Characteristics	81
4.1.2	2 Effects of Time Delay	83
4.1.3	3 Effect of Preionzer Storage and Main Peaking Capacitances	88
4.1.4	4 Output Energies and Efficiencies	90
4.2 HRR Operation		
CHAP	TER 5 CONCLUSIONS	101
5.1 S	ummary of Operational Characteristics	101
5.2 S	ome Comparisons With Other Reported Systems	102
5.3 Si	uggestions for Future Work	103
5.4 C	Conclusions	104

105

REFERENCES