

ENGINEERING REFERENCE DATA

X-75509

WIRE SPRING RELAYS
AF-, AG-, AJ-, AK-, AL-, & AM-TYPES



Bell Telephone Laboratories
Research and Development Unit of the Bell System

INTRODUCTION

This is one of a series of Engineering Reference Data Bulletins containing information on apparatus designed by the Bell Telephone Laboratories, Incorporated, for other than military applications, and manufactured by the Western Electric Company or by other suppliers in accordance with specifications prepared by the Bell Laboratories. It is intended primarily for use by engineers of the Bell Laboratories, and contains information on apparatus which may be rated AT&TCo Standard, A&M Only, Component Part, or Special; codes classified ML; or codes designated for nonassociate use. Codes rated Manufacture Discontinued are not included.

It is planned to bring this bulletin up to date periodically; however, the information contained herein may not be complete and the ratings of the items are not shown. The final selection of apparatus should, therefore, be made on the basis of the usual sources of information such as the Western Electric Apparatus Card Catalog, the manufacturing specifications, and price data. For information regarding the output of apparatus, refer to the Western Electric Report A-822.1.

The bulletin may include some codes of apparatus for which catalog cards will not be found in the Western Electric Apparatus Card Catalog. Such codes are in general rated "Component Part." This rating is applied to apparatus where it is believed that the associated telephone companies will have no need for apparatus card catalog information and orders for the apparatus from the field are not expected.

When apparatus, that is not listed on a white card in the Western Electric Apparatus Card Catalog, is selected for use in new applications, the Head, Standards and Materials Engineering Department, Department 6251, Bell Telephone Laboratories, Incorporated, Holmdel, New Jersey 07733, should be notified of the new use and probable demand so that consideration can be given to rerating the apparatus. When such new applications are made within the Bell Laboratories, the selection should first be discussed with the department responsible for the design of the apparatus.

TABLE OF CONTENTS

SECTION I - GENERAL

- Description
- Relay Types
 - AF Relay
 - AG Relay
 - AJ Relay
 - 24 Make Relay
 - 24 Break Relay
 - AK Relay
 - AL Relay
 - AM Relay
- Magnetic Structure
- Balance Spring
- Core Plate
 - AF, AG, AJ, and AL Relays
 - AK and AM Relays
- Spring Assemblies
- Actuating Card
- Contact Sequences
- Mounting
- Assembly of Coded Parts
- Contact Cover
- Life
- Contact Chatter and Rebound
 - Initial Chatter
 - Shock Chatter
 - Hesitation
 - Rebound
- Short Pulse Operation
- Grounding Strap

SECTION II - CODES

- High-Operation Relays
- Code Numbers
- Spare Contacts
- Procedure
- Adjustments
- Armature Back Tension
- Contact Gauging
- Resistance Tolerances
- Contacts
- Battery Connection to Springs
- Contact Force
- Armature Travel
- Operate and Release Times
- Circuit Preparation
- Maintenance Specifications

SECTION III - SPRINGS

- Armature Travels
- Core Plate
- Contact Arrangements
- Actuating Cards
- Contact Forces
- Contact Sequences
- Spring Combination Numbers
 - AF, AG, AJ, and AL Relays
 - AK and AM Relays
- Balance Springs
- Buffer Spring
- Terminals and Terminal Numbering
- Spring Combinations

SECTION IV - HEATING

- Normal Operating Temperature Limits
- Trouble Temperature Limits

- Indefinite and 48-Hour Trouble Heating Limit
- Maintenance Heating
- Intermittent Heating
- Thermal Conductance
- Allowable Heating
- Resistance Rise
- Heating Conditions
- Temperature Limits for Wire
- Table of Allowable Wattage

SECTION V - MAGNETIC INTERFERENCE

- Effect on Relay Adjustment
- Effect on Relay Performance
- Effect on AK Relays
- Crosstalk

SECTION VI - CONTACTS

- General
- Contact Welding
- Contact Actuation
- Contact Dimensions
- Contact Capability
 - Unprotected Contacts
 - Protected Contacts
- Contact Protection
- Determining Life of Unprotected Contacts
- Determining Contact Protection
- Contact Reliability
- Table of Life Estimates

SECTION VII - TIMES

PART I - OPERATE TIMES

- Listed Operate Times
- Types of Problems
- Definition of Maximum, Minimum, and Average Times
- Load-Controlled Versus Mass-Controlled Solutions
- Choice of Mass-Controlled or Load-Controlled Method
- Calculation of Load-Controlled Operate Time - AF, AG, and AJ Relays
 - Construction of Curves
 - Use of Fig. VII-1 To Obtain Maximum Operate Time
 - Use of Fig. VII-2 To Obtain Minimum Operate Time
 - Use of Fig. VII-2 To Obtain Average Operate Time
- Calculation of Mass-Controlled Operate Time - AF, AG, and AJ Relays
 - Average Operate Time
 - Minimum and Maximum Times
- Calculation of Operate Time - AK Relays
- Calculation of Maximum Stagger Time
 - AF, AG, and AJ Relays
 - AK Relays
- Design for Highest Speed
- Inductances Curves
- Equivalent Circuits
- Simulated Circuits

PART II - RELEASE TIMES

- General
- Definition of Minimum, Maximum, and Average Times

TABLE OF CONTENTS (Cont)

PART II - RELEASE TIMES (Cont)

Factors Controlling Release Time
Release Ampere Turns for Maximum Release Time
 Relays With Operate Requirement Only
 Relays With Nonoperate Requirement
 Relays With Release Requirement
Release Ampere Turns for Minimum Release Time
 Relays With Operate Requirement Only
 Relays With Hold Requirement
 Relays With Nonoperate Requirement
Release Time on Open Circuit With No Shunt
Average Releasing Time
Release Time With Resistive Shunt
Release Time With Sleeves
Release Time With Contact Protection
AK Release Time With Copper Sleeve and Domed Armature
Release Time Under Shunt-Down Condition

SECTION VIII - MECHANICAL REQUIREMENTS

Contact Gauging
 M Specification Values
 Readjust Values
 Wired Equipment Test Values
 Before Turnover Test Values
 Maintenance Test Values
Armature Travel
Contact Force
Armature Back Tension
Buffer Spring Tension and Position
Stop Discs
Armature Leg Clearance - AF, AG, AJ, and AL Relays
Coil Replacement
Adjusting Tools
 AF, AG, AJ, and AL Relays
 AK and AM Relays

SECTION IX - CAPABILITY

PART I - AF, AJ, AND AK RELAYS

Introduction
General
Contact Actuation
 Makes
 Breaks
 Critical Load Points
 Light Contact Forces
Balance Spring Tension
Armature Hinge Tension
Armature Back Tension
Balance Springs
Buffer Springs
Determination of Airgaps
Operate Ampere Turns - Simplified Method
Operate Ampere Turns - Detailed Method
Nonoperate Ampere Turns
Minimum Operated Airgaps
Hold Ampere Turns
Release Ampere Turns
Current Flow Requirements
Check Adjustments

PART II - AG RELAYS AND SLOW RELEASE AK RELAYS

AG Relays
Slow Release AK Relay
Selection of Coded Relay
 List of Codes
 Release Times
 Requirements for CR Table
 Soak Effect
 Effect of Heating on Release Times
 Effect of Magnetic Interference
 Operate Times
General Design Information
Balance Spring Tension
Armature Hinge Tension
Armature Back Tension
Balance Springs
Buffer Spring
Minimum Release Time
Maximum Release Time
Operate Ampere Turns
 AG Relay
 AK Relay
Nonoperate Ampere Turns
Check Adjustments

PART III - AL AND AM RELAYS

Maximum Load Curve - Method of Using - Appendix A
AG or AK Relay with Sleeve - Method of Calculating - Appendix B
AG Relay with External Shunt - Method of Calculating - Appendix C

SECTION X - COILS

General
Available Coils
Winding Dimensions
 AF, AG, and AJ Relays
 AK Relays
Laminations
Sleeves
Winding Arrangements
Coil Design
Full-Spool or Specific Resistance
Resistance Variation
Fast Operate Coils
Coil Cost
List of Coils - AF, AG, AJ, and AL Relays
List of Coils - AK and AM Relays
Wire Tables

SECTION XI - ECONOMICS

When To Code A New Relay
Economic Selection of Coils
Cost of Power
 Cost per Kilowatt of Power Supplied
Economics of Standardization
 Administration Costs
 Manufacturing Costs as Affected by Lot Size
Relation of Cost Penalty to Total Number of Codes
Choice of Number of Codes

X-75509