Bell System Data Communications

TECHNICAL REFERENCE

•

Data Set 301B

Interface Specification

March, 1967

•

ENGINEERING DIRECTOR - DATA COMMUNICATIONS

PREFACE

This specification is specifically intended for designers of business machine equipment to be used with Bell System Data Set 301B.

If additional details on the interface and its operation are needed, please contact:

Engineering Director – Data Communications
American Telephone and Telegraph Company
195 Broadway
New York, N.Y. 10007

TABLE OF CONTENTS

1.00 GENERAL

This technical reference revises and supersedes the June, 1963 issue of the Data Set 301B Interface Specification to include:

1. Additional line signal and line interface information.
2. Additional Idle Circuit Codes.
3. Requirements for powering the Data Set 301B from a regulated d.c. supply where commercial power is not available.
4. A new Burndy plug connector.

1.01 This specification describes the interface signals necessary for operation of the Data Set 301B with connecting data generating or processing terminal equipment. This description includes voltage, current, and loading considerations and the physical interface arrangement. It describes the signals which must be provided to the data set and the signals available from the data set.

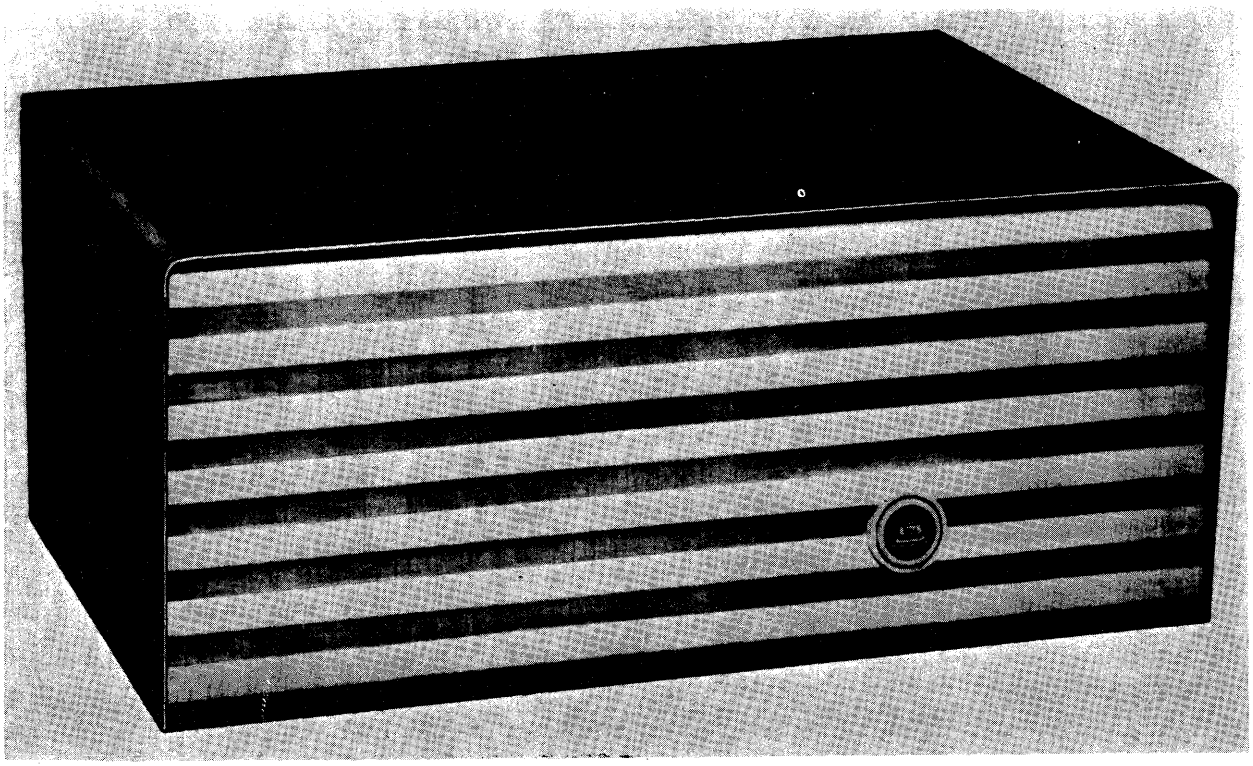


Fig. 1 Data Set 301B

1.02 The set is basically the same as those described in the Technical Reference dated September, 1962 covering the Data Sets 201A and B and also described in AIEE Transaction Paper #62-143 entitled, "PM Data Sets for Serial Transmission at 2,000 and 2,400 Bits per Second" by P.A. Baker, of the Bell Telephone Laboratories.

1.03 The Data Set 301B accepts serialized binary signals from customer-furnished equipment on a synchronous basis at 40.8 kilobits per second. The serialized data signal is encoded two bits (a "dibit") at a time into a relative phase shift of a 30.6 kc carrier. For the four possible dibits (11, 10, 00, 01) the phase of the carrier, transmitted during a dibit time interval, is shifted 1, 3, 5 or 7 times radians (45°) with respect to the carrier phase of the previous dibit time interval. The 20,400 dibit per second modulation results in a line signal spectrum symmetrical about the 30.6 kc carrier frequency in the 10.2 to 51.0 kc pass band. Signals in this spectrum may be transmitted over equalized nonloaded cable pairs, as well as L-type Multiplex and N carrier group bandwidth facilities equipped with suitable wideband modem equipment.

1.04 A voice-frequency coordination channel is furnished as part of the installation for use by the customer.

2.00 MODES OF OPERATION

The Data Set 301B may be operated in either of two basic modes.

a. Internal Synchronization – in this mode the data set derives its timing from an internal oscillator and provides a bit synchronization signal to the business machine.

b. External Synchronization – in this mode the data set derives its timing from the bit synchronization signal provided by the business machine. The business machine must supply a 40.8 kc ±.01% square wave with a 50 ±10% duty cycle.

Either of the above modes may be selected by strapping the appropriate terminals in the transmitter.

3.00 SIGNALS

3.01 Signals accepted by the Data Set at Customer Interface.

The data set circuitry is designed to accept three signals on interchange leads from the connecting data equipment:

a. SR – Send Request

b. SD – Send Data

c. SCTE – External Serial Clock Transmit (used when data set is to be driven by the business machine timing source).

3.02 Signals delivered by the Data Set at Customer Interface

Data set circuitry is designed to deliver or make available seven signals or interchange leads to the connecting data equipment:

a. SCT – Transmitter 40.8 kc Clock

b. DCT – Transmitter 20.4 kc Clock

c. SCR – Receiver 40.8 kc Clock

d. RD – Received Data

e. COO – Carrier On-Off

f. IT – Interlock

g. CS – Clear to Send

3.03 Description of Interface Signals

3.031 The data set is provided with cable drivers and cable terminators which become part of the interchange circuits that interconnect the data set and the business machine. The cable drivers operate into, and the cable terminators operate from, coaxial cables of from 90 ohms to 120 ohms characteristic impedance. The interface is provided on a current switching basis and the use of coax is necessary to preserve the rise times of interface wave forms. It is expected that the business machine will be supplied with the coax cables. Circuit diagrams for typical drivers and terminators are shown in Figure 2.

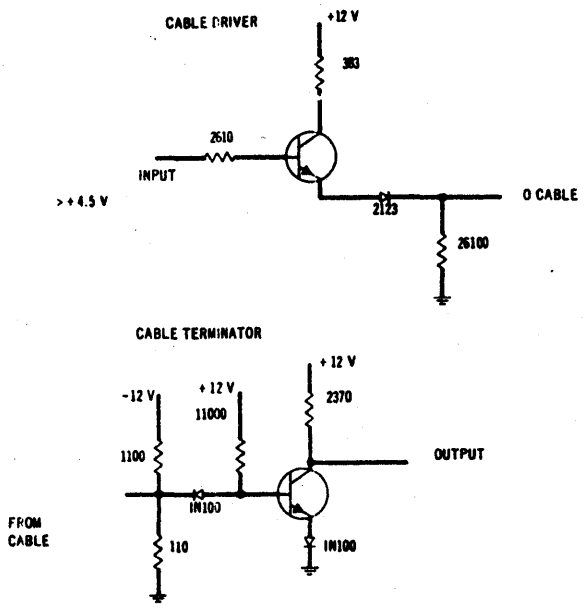


Fig. 2 Typical Cable Drivers and Cable Terminators

3.032 In the data set, cable drivers are provided where signals are delivered from the data set to the connecting data equipment and cable terminators are provided where signals are delivered from the connecting data equipment to the data set. A binary "1," control "off" or "marking" signal is represented by a current less than 5 ma into 100 ohms. A binary "0," control "on" or "spacing" signal is represented by a current greater than 23 ma into 100 ohms. These apply to all interchange circuits. In addition, the IT (interlock) circuit presents an impedance greater than 300 ohms to ground to indicate the power "off" condition.

3.033 The above-mentioned currents are supplied at the output of the cable drivers as required and they should be supplied to the cable terminators. With less than 5 ma into 100 ohms supplied to a cable terminator, the terminator input voltage is more negative than -0.7 volts. The negative voltage is added by a bias in the terminator. With greater than 23 ma into 100 ohms supplied to a cable terminator, the terminator input voltage is more positive than

+1.0 volts. An open circuit must be recognized by a terminator as "off."

3.04 Signals Delivered to Transmission Line

a.	Carrier Frequency	30.6 kc
b.	Frequency Spectrum	10.2 to 51.0 kc
c.	Modulation	Four Phase
d.	Output Signal Power	+10.0 dBm ±1.0 dB (not adjustable)
e.	Nominal Output Impedance	135 ohms (balanced)

3.05 Signal Received from Transmission Line

a.	Minimum Input Signal Power	-50.0 dBm
b.	Maximum Input Signal Power	+10.0 dBm
c.	Nominal Input Impedance	135 ohms (balanced)
d.	Automatic Gain Control (AGC) Range	30 dB

3.051 Input strappings for three input signal power ranges are as follows:

Range	Strapping (SD-1D021-01-B19)
+10 to -20 dBm	E1 to E4
-5 to -35 dBm	E1 to E3
-20 to -50 dBm	E1 to E2

3.06 Description of Line Signals

The Data Set 301B uses a quaternary coding scheme to modulate 40.8 kilobits per second into four relative phase positions of a 30.6 kc carrier. As a result of this phase shift modulation, the carrier is suppressed when random data is transmitted, and the +10.0 dBm ±1.0 dB output power is spread over the 10.2 to 51.0 kc band. Fig. 3 shows the distribution of the relative amplitudes in dB of the repeated dibit codes 11, 10, 00 and 01, as well as the Idle Circuit Code 10-00.

4.00 INTERCHANGE SIGNAL – TYPICAL OPERATION

4.01 SR – Send Request

4.011 The Send Request circuit should be held in an "off" condition at all times except when the connecting data equipment wishes to send actual data. In the "off" condition the data set automatically transmits a line signal corresponding to be repeated "10-00" dibit code to keep the receiver in a bit synchronization. The major single frequency component in the spectrum of the repeated 10-00 Idle Code is 30.6 kc. This particular frequency is optimum from a telephone crosstalk interference standpoint in the telephone Plant. However, because of the pressing need by some sophisticated data processing systems for Idle Codes other than the 10-00 code, the following 17 codes are available as a result of a compromise in the transmission objective. On a repeated basis, these 17 codes produce only five different spectra.

Compromise Idle Codes

7 Bit Code

1111100

8 Bit Codes

00101101	00011110
01011010	00111100
10110100	01111000
01101001	11110000
11010010	11100001
10100101	11000011
01001011	10000111
10010110	00001111

The above compromise Idle Codes are available for use during transmission of data. When the connecting data equipment is idle, the Send Request circuit should be in the "off" condition.

4.012 If the business machine generates the 10-00 Idle Code, the start of the "1" should be coincident with the positive going transition of the DCT (Dibit Clock Transmit). When the SR signal is switched to "on," the Clear-to-Send circuit will be switched "on" as described below.

4.02 CS – Clear To Send

When the Request-to-Send circuit is held in the "off" condition, the Clear-to-Send circuit will hold an "off" signal to the customer's data equipment, indicating that the data set will not accept data. When the SR circuit is switched "on" by the customer's data equipment, the data set will not complete the idle character being transmitted, but will switch the CS Circuit to "on" immediately (within 1 microsecond). The SR should be switched "off" coincident with the positive going transition of the SCT that occurs at the end of the last data bit. Then

CS switches off immediately.

4.03 SCTE – External Serial Clock Transmit

The SCTE circuit is used only when the data set is to be driven by the customer's clock signal (external sync. option). When operated in this manner the customer's timing source must supply a 40.8 kc ±0.01% square wave signal with a 50 ±10% duty cycle to the SCTE circuit. Positive going transitions of the signal should be coincident with the change of data on the SD circuit. The data will be sampled by the data set coincident with the negative going transition of the SCTE signal.

4.04 DCT – Dibit Clock Transmit

A clock signal at half the bit rate (20.4 kc) is made available to the customer on the DCT circuit whether the data set is operated with internal or external synchronization options. Signal transitions are coincident with positive going transitions of the SCTE.

4.05 SCT – Transmitter 40.8 kc Clock

The SCT circuit is used by the customer only when the data set supplies the master timing signal (internal sync. option). When operated in this manner the data set supplies a 40.8 kc ±.01% square wave signal with a 50 ±10% duty cycle to the customer's data equipment on the SCT circuit. The customer must change data on the SD circuit coincident with positive going transition of the SCT. The data is then sampled by the data set coincident with the negative going transition of the SCT signal. When the data set is connected for external timing, the SCT is used for testing without dependence on the business machine equipment.

4.06 SD – Send Data

The SD circuit is designed to accept serial data from the customer's data equipment as timed by the SCTE or SCT signal. In either case the data must be changed at the positive going transition of the timing signal. The data signal should be maintained on the SD circuit for the full bit period duration. The data is sampled by the data set coincident with the negative going transition of the timing signal.

4.07 SCR – Serial Clock Receiver – 40.8 kc

Bit synchronization is recovered by the data set receiver directly from the line signal. A square wave clock signal is delivered to the customer's data equipment on the SCR circuit, exactly synchronized with the received data being delivered on the RD circuit. Data is changed on the RD circuit coincident with the positive going transition of the SCR signal and should be sampled at the negative going transition of the SCR signal. Use of the SCR signal is optional to the customer, as the connecting data equipment may be arranged to recover synchronization from the data transitions.

4.08 RD – Received Data

Received data is delivered serially on the RD circuit to the customer's data equipment. The DC data is always regenerated and clocked to the RD circuit under control of the recovered SCR timing signal.

4.09 COO – Carrier On-Off

The COO circuit delivers an "off" signal when line signal carrier is not present at the data set receiver. The COO signal is switched to "on" within a maximum of 6 milliseconds after carrier is received. Upon loss of carrier a maximum of 10 milliseconds may be required for for the COO signal to be switched "off."

4.10 IT – Interlock

The IT circuit delivers a current greater than 23 ma into 100 ohms as an "on" signal to the customer's data equipment. An "on" signal will be delivered while the data set has power turned "on" and is not in a test condition. An "off" signal indicates that the data set is not in a condition allowing transmission of data and is indicated by a current of less than 5 ma into 100 ohms. The IT circuit presents an impedance of greater than 300 ohms to ground to indicate the "power off" condition. The operation of the "Line and Test Key" places a short across this impedance and effectively grounds the IT circuit.

5.00 IDLE CIRCUIT CODE 10-00

During idle periods the Data Set 301B, operating from its internal clock, automatically transmits a repeated Idle Circuit Code 10-00. When the customer supplies the clock, he should supply the clock continuously, even when SR (Send Request) is "off" to insure automatic transmission of the 10-00 code.

The Idle Circuit Code performs the following functions:

1. Keeps the overall data system in bit synchronism.

2. Keeps the line signal output power of the 301B at a uniform level. This enables regulation of local loop repeaters to correct for level changes due to variation of cable temperature.
3. Provides a convenient test signal for check of level and wave form at intermediate points by the Telephone Company maintenance forces.

Loss of the 10-00 code signal during idle circuit conditions will result in excess repeater gain. This may produce oscillation of the data channel at a discrete frequency which may disturb other telephone service. The 301B must, therefore, be continuously energized by commercial power.

6.00 MISCELLANEOUS – DATA SET 301B

6.01 Interchange Circuit Connections

6.011 All interchange circuits are terminated in a 12 pin Burndy No. MD12MXP-17TC coaxial connector located on the back of the data set chassis. This connector is labelled "Cust. Equip." Circuit terminations are as follows:

a. DCTE Dibit Clock – Transmitter – External (see Note1)
b. DCT Dibit Clock Transmit (20.4 kc)
c. CS – Clear to Send
d. SR – Send to Request
e. SD – Send Data
f. IT – Interlock
g. DCR – Dibit Clock Receiver (see Note 1)
h. SCTE – Serial Clock Transmit (External Sync. Option)
j. SCT – Serial Clock Transmit (Internal Sync. Option)
k. RD – Receive Data
l. SCR – Serial Clock Receive
m. COO – Carrier On-Off

Note 1: These terminations are used by the Telephone Company when data set is used as a signal regenerator.

6.012 The business machine equipment is expected to be provided with not more than fifty (50) feet of coaxial cable between the data processing equipment and the data set interface connector. The cable should be equipped with a Burndy No. MD12XP-17C plug connector and a Burndy No. M2H5ORC-1P2 protective shield.

6.013 For Telephone Company test purposes all interchange circuits are multipled to a KS-19087L2 25 pin connector labelled "TST" also mounted on the back of the data set chassis. These circuit appearances are used for the connection of suitable data test set equipment when the customer's interface is disconnected. These appearances are not intended for customer use.

6.02 Grounding

All interchange circuit connections are to be made through coaxial leads. The sleeve of each coaxial lead is connected to signal ground. Within the data set, signal ground is common to chassis ground and the AC power supply protective ground. AC power supply arrangements for the customer's data equipment and the data set should be such that under any circumstance the difference in ground potential does not exceed ±0.5 volts.

6.03 Packaging

The Data Set 301B is packaged as a complete transmitter-receiver in a gray metal cabinet 17-9/16" wide x 11-11/16" deep x 7-3/4" high. The design is intended for desk or table top mounting or may be mounted on shelves in a standard 19" relay rack. The data set weighs approximately 35-1/2 lbs.

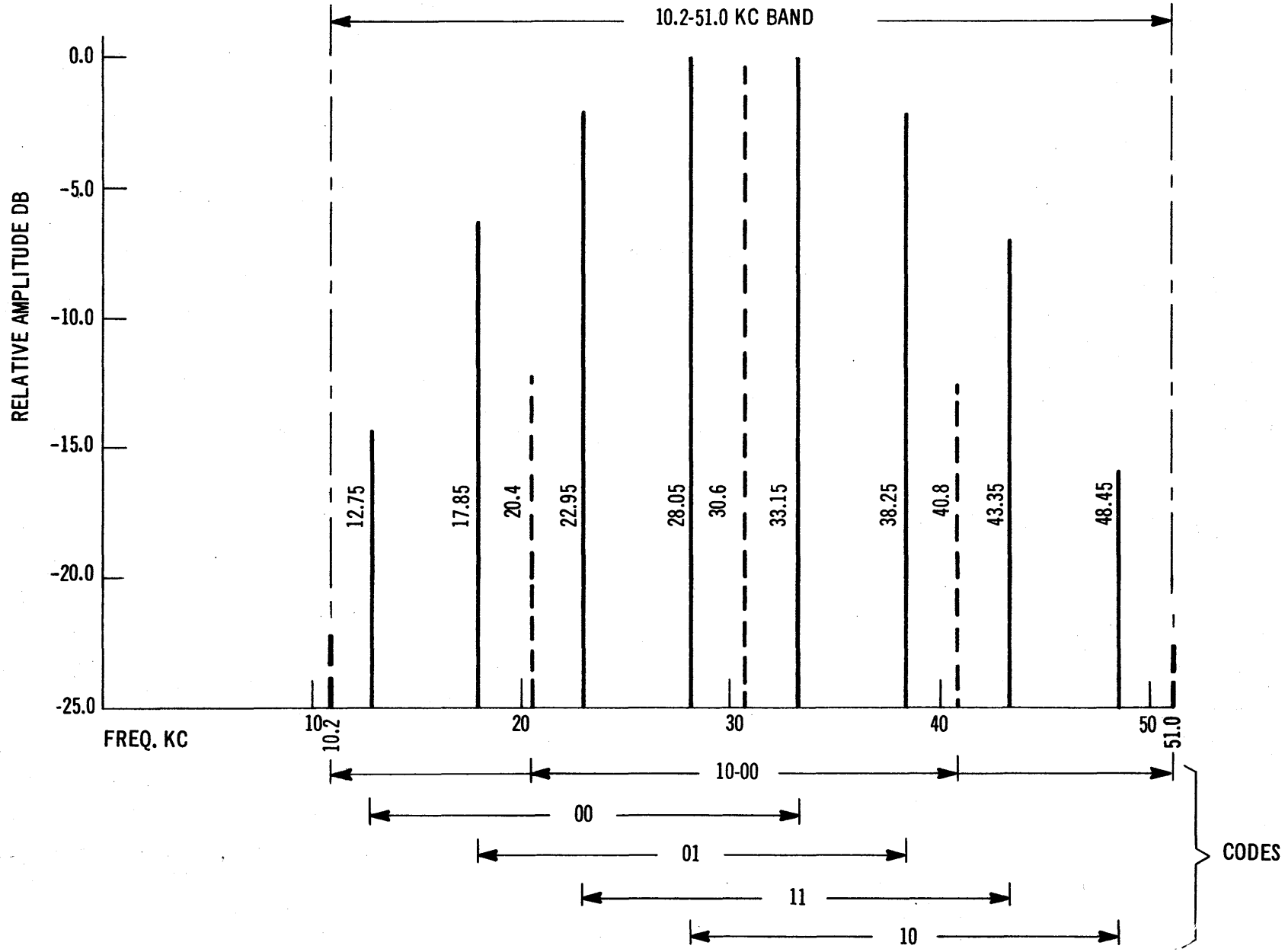
6.04 Power Requirements

6.041 Approximately 20 watts of 60 cps power at 106-129 volts is required for the 301B. The power supply frequency tolerance is 60 ±1% or 60 ±0.6 cycles.

6.042 Where the 60 cycle frequency requirement cannot be met, an external power supply may be used. The d.c. requirements of the 301B are as follows:

Nominal D.C. Supply	Voltage Variation	Current
+12V	+0.4V -0.8V	685 ma
-12V	+0.8V -0.4V	295 ma

6.043 In some cases it may prove essential that the power service ground bus be common to the data set and the customer's data equipment. In the event that ground loops prove a problem in a particular installation, it may prove necessary to obtain power from an auxiliary outlet located on the business machine equipment.


10.2-51.0 KC BAND
RELATIVE AMPLITUDE DB
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
12.75
17.85
20.4
22.95
28.05
30.6
33.15
38.25
40.8
43.35
48.45
FREQ. KC
10
10.2
20
30
40
50
51.0
10-00
00
01
11
10
CODES