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Technology Series

Introduction to MFC-R2 Signaling

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1 ABOUT SIGNALING SYSTEM R2 (THE BACKGROUND)

This section is intended to help readers who are not familiar with the Multifrequency Compelled R2 Signaling System (MFC-R2). Refer to ITU-T Q.400 Series for detailed information.

1.1 Line Signals, Digital Version (defined in ITU-T Q.421)

Line signals are the ABCD bits of Channel Associated Signaling (CAS) in timeslot 16, which represent the states of the line. They are similar to the states of an analog line. Each bit has a meaning, but bits C and D are rarely used in the real world, and they are left constant (national variant dependant). They are usually shown as XX and the most common value for them is 01. Refer to Figure 1.

The combinations of forward and backward signals, as shown in Table 1, define the states of a line. ITU-T Q.421 is the standard supported by the SunSet handheld test sets.

State of the Circuit	Signaling Code	
	Forward	Backward
	A B	A B
Idle/Released	1 0	1 0
Seized	0 0	1 0
Seizure Acknowledged	0 0	1 1
Answered	0 0	0 1
Clear-back	0 0	1 1
Clear-forward	1 0	0 1
Clear-forward	1 0	1 1
Blocked	1 0	1 1

Table 1 ITU-T Q.421/Table I

1.2 Line Signals, Analog Version (defined in ITU-T Q.411)

In this case, only bit A is used to represent the signals "tone on" and "tone off", while the B C D bits are fixed. The line signals are represented as 1XXX and 0XXX. This version is not directly supported by the SunSet units, but users can easily modify the user's line signaling tables or use a call emulator script to operate in this mode.

1.3 Inter-register Signals (defined in ITU-T Q.441)

These are 2-out-of-6 in-band multitone signals sent in both directions associated with the registers used to control the switching process. It takes two tones (frequencies) out of a set of six to create a multitone signal. To generate forward and backward multitone signals, two sets of six frequencies are used. These include digits, user category, register index control, etc.

Signals sent by the originating point (switch) are called forward and signals sent by the terminating point are called backward. Each (forward and backward) has two lookup tables to assign/decode the meaning of each tone. They are tables I and II for forward and A and B for backward. Refer to the following ITU-T Q.441 Tables 2-5. In some cases, people also refer to tables III and C, which are used for calling-party identification. Tables III and C are similar to tables I and A.

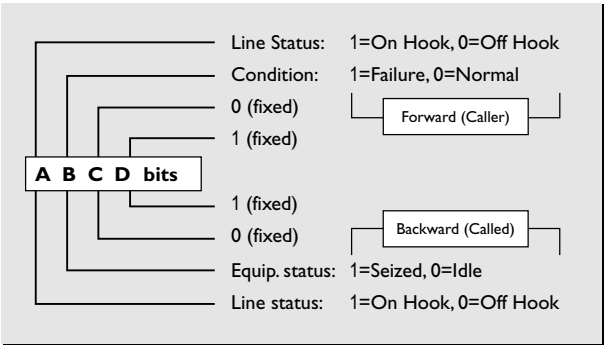

Figure 1 Line signals, digital version

Any call will start assigning the digits the meaning of table I, in the forward direction, and table A in the backward direction. Some backward signals require responses from table II and switch to table B. The backward sequence always controls the tables used for decoding/understanding each signal that has been received and sent.

MF	Designation	Meaning
1	I-1	Digit 1 (Language: French, if first signal sent in intl. link)
2	I-2	Digit 2 (Language: English, if first signal sent intl. link)
3	I-3	Digit 3 (Language: German, if first signal sent in intl. link)
4	I-4	Digit 4 (Language: Russian, if first signal sent in intl. link)
5	I-5	Digit 5 (Language: Spanish, if first signal sent in intl. link)
6	I-6	Digit 6 (Language: Spare, if first signal sent in intl. link)
7	I-7	Digit 7 (Language: Spare, if first signal sent in intl. link)
8	I-8	Digit 8 (Language: Spare, if first signal sent in intl. link)
9	I-9	Digit 9 (Discriminating digit, if first signal sent in intl. link)
10	I-10	Digit 0 (Discriminating digit, if first signal sent in intl. link)
11	I-11	Country code indicator, outgoing half-echo suppressor required
12	I-12	Country code indicator, no echo suppressor required
13	I-13	Test call indicator (call by automatic test equipment)
14	I-14	Country code indicator, outgoing half-echo suppressor inserted
15	I-15	Signal is not used

Table 2 ITU-T Q.441/Table 6, Group I forward signals

MF	Designation	Meaning
1	II-1	Subscriber without priority
2	II-2	Subscriber with priority
3	II-3	Maintenance equipment
4	II-4	Spare
5	II-5	Operator
6	II-6	Data trannsmission
7	II-7	Subscriber (or operator without forward transfer facility)
8	II-8	Data transmission
9	II-9	Subscriber with priority
10	II-10	Operator with forward transfer facility
11	II-11	Spare, for National use
12	II-12	
13	II-13	
14	II-14	
15	II-15	

Table 3 ITU-T Q.441/Table 7, Group II forward signals

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MF	Designation	Meaning
1	A-1	Send next digit (n+1)
2	A-2	Send last but one digit (n-1)
3	A-3	Address-complete, changeover to reception of Group B signals
4	A-4	Congestion in the national network
5	A-5	Send calling party's category
6	A-6	Address-complete, charge, set-up speech conditions
7	A-7	Send last but two digit (n-2)
8	A-8	Send last but three digit (n-3)
9	A-9	Spare, for National use
10	A-10	
11	A-11	Send country code indicator
12	A-12	Send language or discrimination digit
13	A-13	Send nature of circuit
14	A-14	Request for information on use of an echo suppressor
15	A-15	Congestion in an international exchange or at its output

Table 4 ITU-T Q.441/Table 8, Group A backward signals

MF	Designation	Meaning
1	B-1	Spare, for National use
2	B-2	Send special information tone
3	B-3	Subscriber's line busy
4	B-4	Congestion (after changeover from Group A to B)
5	B-5	Unallocated number
6	B-6	Subscriber's line free, charge
7	B-7	Subscriber's line free, no charge
8	B-8	Subscriber's line out of order
9	B-9	Spare, for National use
10	B-10	
11	B-11	
12	B-12	
13	B-13	
14	B-14	
15	B-15	

Table 5 ITU-T Q.441/Table 9, Group B backward signals

1.4 Different Types of MFC Calls (samples)

The following samples are based on ITU-T recommendations. National variants may be different.

1.4.1 Simple Calls

Used between a Central Office (switch) and a PBX, for local calls (toll free). Refer to Figure 2.

	Line Signaling	Called Number (MFC)	CTRL	Answer & Release (Line)
F **A** B	IDLE SEIZE ACK	I7 I6 I5 I4 I3 I2 I1 A1 A1 A1 A1 A1 A1	II-1 A3 B6[2]	*Talk* CLRF IDLE *Ring* ANSW *Talk* CLRB IDLE
B	Same	Same	Same	*Talk* CLRF IDLE *Ring* ANSW *Talk* IDLE
C	Same	Same	Same	*Timeout* CLRF IDLE *Ring* IDLE
D	Same	Same	II-1 A3 B3[3]	*Busy* CLRF IDLE IDLE

Note 1: This could be any of the following categories: II-1 through II-10.
Note 2: This could be any of the following status signals: B-6 User free/Charge, B-7 User free/No Charge.
Note 3: This could be any of the following status signals: B-3 User Busy, B-4 Congestion, B-5 Unallocated.
Note 4: Although *Ring*,*Talk*, and *Timeout* labels are shown in the line signaling, they are not line signals or MFC signals. They are just for reference. *Ring* means that the central office is generating the intermittent tone to alert the Caller that the telephone on the other side is ringing. *Talk* means that both sides are talking. *Timeout*, usually after 10 rings, the switch will clear the call, assuming that nobody is there to pick up the phone.

A: Call goes through, it is answered, they talk, and Called Party releases the call.
B: Call goes through, it is answered, they talk, and Calling Party releases the call.
C: Call goes through, it is not answered within a period, then the switch releases the call.
D: Call does not go through and switch releases the call.

Figure 2 Simple calls

1.4.2 Direct Inward Dialing (DID)

Usually companies with a large number of users have their own numbering plan (or subset), called DID service, which allows users to receive direct calls to their extensions without an operator. For instance, in Sunrise Telecom, all DID telephone numbers start with 360, followed by the internal number (extension). When the local switch gets a call for Sunrise's PBX, it only transmits the extension number (to save time), since the prefix 360 is redundant and since four digits are enough for the PBX to route the call. For some users, the first four digits are redundant, so their PBX only gets three digits from the switch. Figure 3 shows DID calls to the telephone 7654321 in a PBX that has telephone numbers assigned from 7654000 to 7654999.

	Line Signaling	DID #	CTRL	Answer & Release (Line)
F **A** B	IDLE SEIZE IDLE ACK	I3 I2 I1 A1 A1	II-1 A3 B6[2]	*Talk* CLRF IDLE *Ring* ANSW *Talk* CLRB IDLE
B	Same	Same	Same	*Talk* CLRF IDLE *Ring* ANSW *Talk* IDLE
C	Same	Same	Same	*Timeout* CLRF IDLE *Ring* IDLE
D	Same	Same	II-1 A3 B3[3]	*Busy* CLRF IDLE IDLE

Figure 3 Direct Inward Dialing (DID) calls

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1.4.3 Calls with Caller ID Request

This is used between central offices for tracking and billing purposes. The Caller's Party Category is sent in response to the first A-5. The following example shows 9876543 calling 7654321.

	Line Signaling	Called Number (MFC)	CTRL and Caller ID	Answer & Release (Line)
F A B	IDLE SEIZE ACK	I7 I6 I5 I4 I3 I2 I1 A1 A1 A1 A1 A1 A1	II1[1] I9 I8 I7 I6 I5 I4 I3 II5[5] II1[1] A5[6] A5[7] A5 A5 A5 A5 A5 A5 A5 A3 B6[2]	*Ring* ANSW *Talk* CLRB CLRF IDLE *Talk* IDLE
B	Same	Same	Same	*Ring* ANSW *Talk* *Talk* CLRF IDLE IDLE
C	Same	Same	Same	*Ring* *Timeout* CLRF IDLE IDLE
D	Same	Same	II1[1] I9 I8 I7 I6 I5 I4 I3 II5[5] II1[1] A5[6] A5[7] A5 A5 A5 A5 A5 A5 A5 A3 B3[2]	*Busy* CLRF IDLE IDLE
E	IDLE SEIZE ACK	I3 I2 I1 I4 I3 I2 I1 A1 A1 A1 A1 A1 A1	II1[1] I9 I8 I7 I6 I5 I4 I3 II5[5] II1[1] A5[6] A5[7] A5 A5 A5 A5 A5 A5 A5 A3 B6[2]	*Ring* ANSW *Talk* CLRB CLRF IDLE *Talk* IDLE
F	Same	Same	Same	*Ring* ANSW *Talk* *Talk* CLRF IDLE IDLE
G	Same	Same	Same	*Ring* *Timeout* CLRF IDLE IDLE
H	Same	Same	II1[1] I9 I8 I7 I6 I5 I4 I3 II5[5] II1[1] A5[6] A5[7] A5 A5 A5 A5 A5 A5 A5 A3 B3[3]	*Busy* CLRF IDLE IDLE

Note 5: This could be any of the following final stages: I-10 through I-15. I-15 or "F" is the most common. This depends on national variants.
Note 6: The first A-5 means "Send Calling Party's Category" and requires a type II response. This is a temporary change to table II.
Note 7: If a second A-5 is received, this has a different meaning "Send Calling Party's Number." The receiver side will continue to send A-5, asking for the next digit, until it receives the final flag (usually I-15 or I-12). This is because the receiver does not know how many digits to expect (maybe seven, eleven, or more).
Note 8: Q.480 also specifies that and I-12 (request not accepted) shall be sent as a response to A-9 or A-10. A-9 and A-10 may be used in national variants to request Calling Party's Category.

A: Call goes through, it is answered, they talk, and Called Party releases the call.
B: Call goes through, it is answered, they talk, and Calling Party releases the call.
C: Call goes through, it is not answered within a period, then the switch releases the call.
D: Call does not go through and switch releases the call.
E: Call goes through, it is answered, they talk, and Called Party releases the call.
F: Call goes through, it is answered, they talk, and Calling Party releases the call.
G: Call goes through, it is not answered within a period, then the switch releases the call.
H: Call does not go through and switch releases the call.

Figure 4 Calls with Caller ID request

1.4.4 Charge Signal (Line Signaling with Metering, Q.400 Series Supplement No.6)

During the talk period, after B-6 (User Free/Charge), there may be charge pulses for billing purposes. Charge pulses are line signals sent by the "called" switch (backward). To send the metering pulse, the switch will toggle the backward A bit every XX ms, so the signal will be changing between 01XX and 11XX. To avoid confusion with clear-back, a new table had been defined in Supplement No.6, replacing it with forced-release. Refer to Table 6. Figure 5 shows a sample of calls with metering.

State of the Circuit	Signaling Code	
	Forward	Backward
	A B	A B
Idle/Released	1 0	1 0
Seized	0 0	1 0
Seizure Acknowledged/Meter	0 0	1 1
Answered/Meter	0 0	0 1
Clear-forward	1 0	0 0
Clear-forward	1 0	0 1
Clear-forward	1 0	1 1
Forced Release	0 0	0 0
Blocked	1 0	1 1

Table 6 ITU-T Q.400 Series Supplement No.6/Table 1

	Line Signaling	Called Number (MFC)	CTRL	Answer & Release (Line)
F A B	0xx 00xx 0xx 11xx *Idle Seiz Ack*	I7 I6 I5 I4 I3 I2 I1 A1 A1 A1 A1 A1 A1	II1[1] A3 B6	*Ring* *Answ* *Metr* *Metr* *Metr* *Metr* *Rele* *ClrF* *Idle* 01xx 11xx 01xx 11xx 01xx 00xx 10xx 10xx 10xx
B	Same	Same	Same	*Ring* *Answ* *Metr* *Metr* *Metr* *Metr* *ClrF* *Idle* 01xx 11xx 01xx 11xx 01xx 10xx 10xx
C	Same	Same	Same	*Ring* *Answ* *Metr* *Metr* *Metr* *Metr* *Metr* *ClrF* *Idle* 01xx 11xx 01xx 11xx 01xx 01xx 10xx 10xx

Figure 5 Line signaling with metering

2 WHERE THESE SIGNALS ARE GENERATED

Some people tend to confuse MFC-R2 signaling with the signaling between telephones and switches (subscriber signaling), but it is signaling between switches. Figure 6 shows the end-to-end process of a call and some of the release possibilities.

The figures below show different ways that the call could end. Only the parts different from Figure 6 are shown.

For test purposes, the sequence shown in Figure 9 could also be used for Unallocated Number. But, in real life, the local switch may transfer the caller to a recorded message.

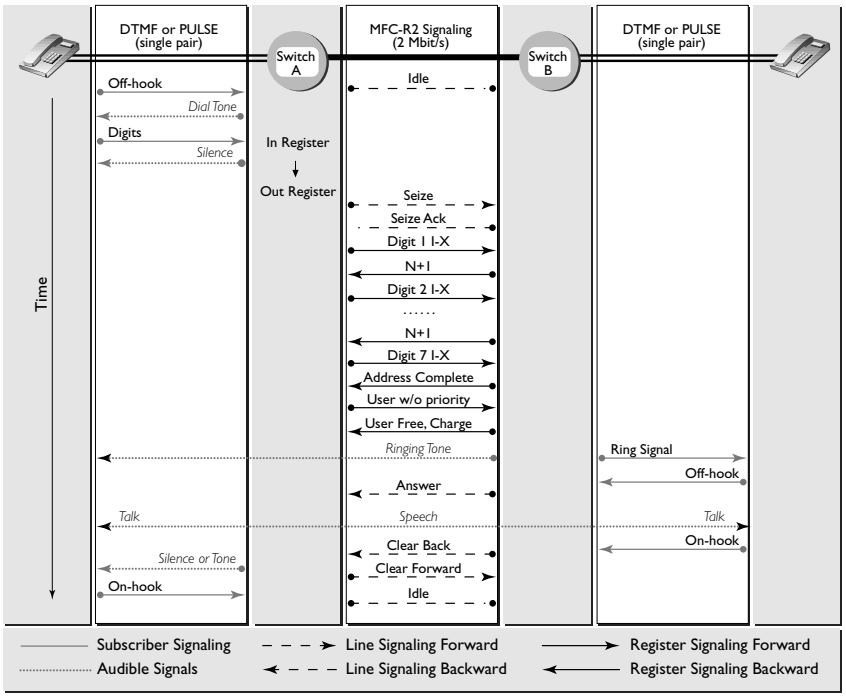

Figure 6 Called party answers and releases the call

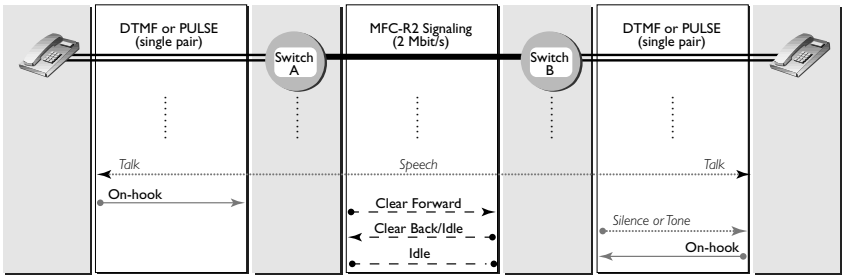

Figure 7 Caller party releases the call

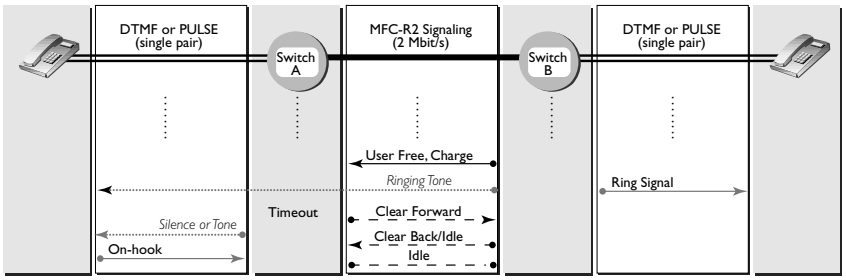

Figure 8 Called party available, but no answer

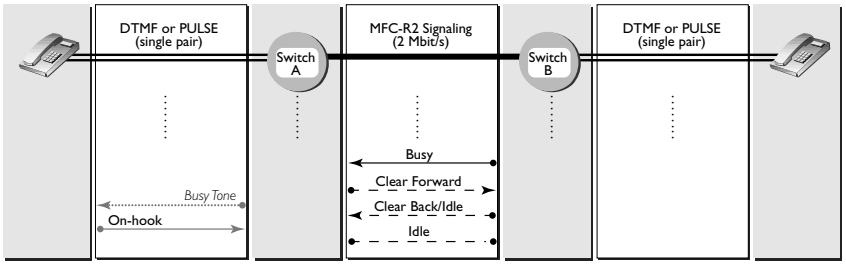

Figure 9 Called party busy or congested

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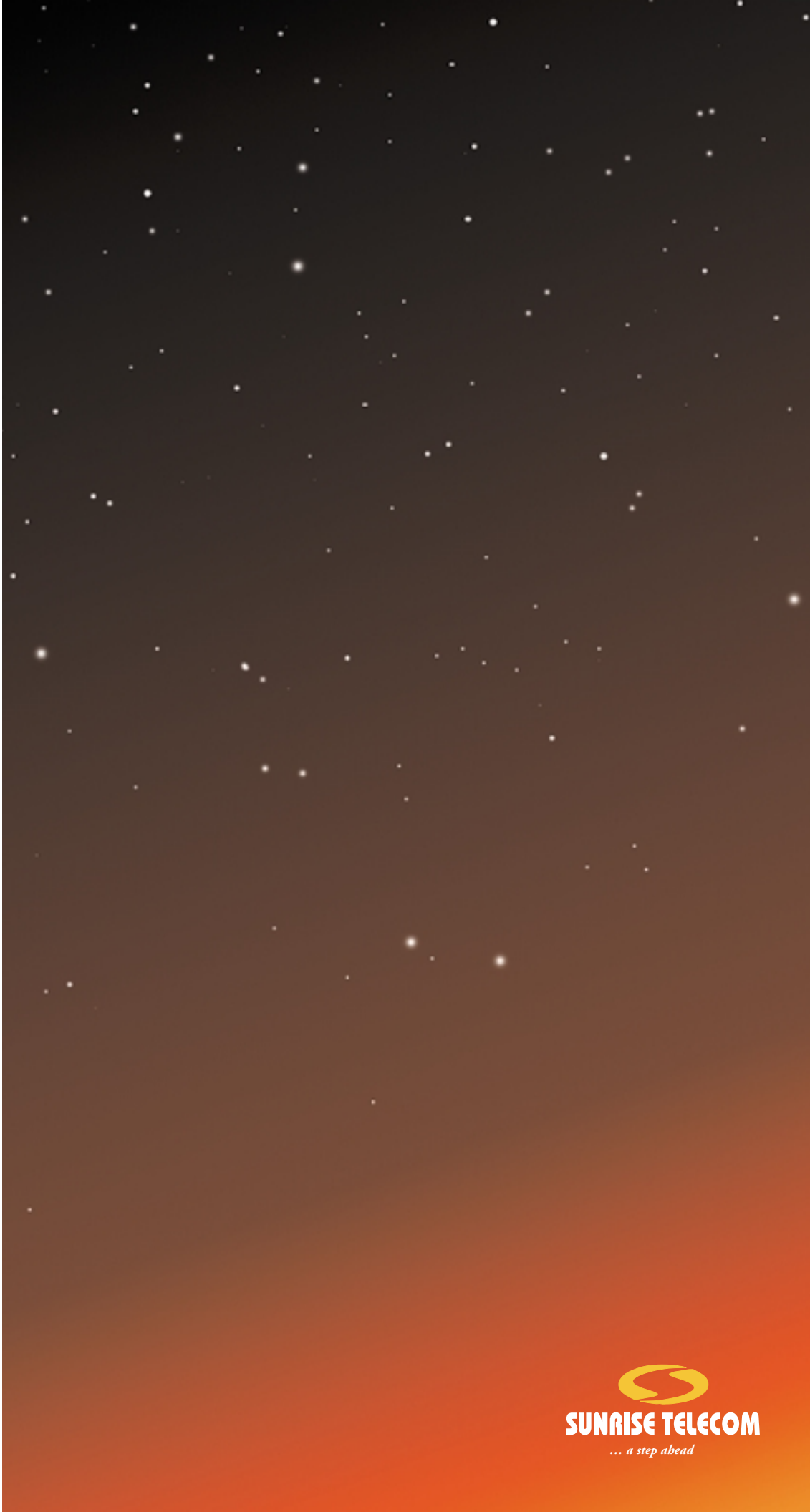
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